SCIENCE ABSTRACTS.

Section A.—PHYSICS.

AUGUST 1923.

GENERAL PHYSICS.

1281. *Fundamental Principles of Scientific Inquiry.* **Dorothy Wrinch and H. Jeffreys.** (Phil. Mag. 45. pp. 368-374, Feb., 1923.)—Following up a previous paper [Abstract 5 (1922)], the authors show that laws in a form containing variable parameters are not in forms suitable for comparison of their probabilities; the differential forms of the same laws may be. The law established with a high probability by experience is never an approximation to the exact simple law, but the exact simple law itself. The "true value" can in no case be determined uniquely from the knowledge at our disposal. The observations do not in fact as a rule satisfy the law; they depend upon sensations; and the laws of physics are derived from measures, with the assistance of certain non-logical principles of which the principle of simplicity is among the chief. Any observed measure is liable to differ slightly from the measure of the same quantity calculated by inference from the law established (margin of error). The fundamental propositions of science include facts of sensation; and principles of probability inference, including empirical generalisation, are employed in the development, which leads up to the adopted values. A. D.

1282. *Mechanical Vibrating Systems under Impulsive Forcing.* **K. Krüger.** (Ann. d. Physik, 70. 4. pp. 291-302, Feb. 22, 1923. Extract.)—A mathematical paper in which is investigated, for small dampings, the influence of phase of impulsive impressed forces on the amplitude and frequency of the forced vibrations. A number of graphs are given in illustration of the calculated results. E. H. B.

1283. *Vibrations of a Particle due to Periodically Repeated Impulses.* **K. C. Kar.** (Phys. Zeits. 24. p. 63, Feb. 1, 1923.)—Using Rayleigh's solution for the equation of motion of a damped particle, and his equation for the effect of an impulse upon it, a solution of the problem is obtained in a few lines, which agrees with that obtained by E. Budde. [Abstract 656 (1917).] H. N. A.

1284. *The Pressure Dependence of the Damping of a Disc Oscillating about a Vertical Axis.* **R. Suhrmann.** (Zeits. f. Physik, 14. 1. pp. 56-62, 1923.)—For the determination of the viscosity of gases from the damping of oscillating bodies, spheres, cylinders, or discs are generally employed. Hitherto discs so suspended that they oscillate like a vane have been seldom used, because the observed damping is only independent of pressure within a certain range. The author has only been able to find one practical investigation of this problem, that by Crookes for a mica vane; its theoretical treatment by Stokes is only partly in agreement with Crookes' observations. The present investigation uses a modified method based on that employed by Crookes by which results are obtained confirming the Stokes theory, and affording useful values for the coefficients of viscosity of several gases and vapours. Experimental details are given with illustrative diagrams and data for hydrogen, oxygen, carbon dioxide, ethyl ether, carbon bisulphide, chloroform, and benzene. H. H. Ho.

1285. *Specific Gravity of Coke.* **W. A. Selvig** and **W. L. Parker.** (Chem. and Met. Eng. 28. pp. 547–550, March 21, 1923.)—A method for determining the specific gravity of coke was developed, and adopted to finding the porosity. For calculating the percentage by volume of cell space of metallurgical coke, the following points were found to be necessary: True specific gravity may be satisfactorily determined by boiling the pulverised coke in water at atmospheric pressure for 1 hour in a convenient pycnometer. The experiments showed that it was not necessary to boil under reduced pressure, or to boil for longer than 1 hour. It appears desirable that the coke should be pulverised so as to pass through a 200-mesh sieve, when the true specific gravity is to be determined. The use of other mediums instead of water is not recommended, since benzene tends to give lower values than when water is used. When the apparent specific gravity of lump coke is determined, a correction must be applied for the water absorbed. The method of determining apparent specific gravity, using a sample of 20–30 lbs. of large pieces of coke, and correcting for water absorbed, is recommended. F. J. B.

1286. *Longitudinal Elasticity and Poisson's Ratio of India-Rubber.* **G. B. Deodhar.** (Phil. Mag. 45. pp. 471–479, March, 1923.)—Tensile experiments are described on long and thick specimens of india-rubber, and initial and final stages of stretching are found where (stretched length)^2/(Young's modulus) = constant holds good. This ratio is not true for intermediate stages where the stretched length is between 5/4 and 2 times the original length. The experimental results are not correctly represented by Ono's stress and strain formula. Poisson's ratio for india-rubber decreases with increasing length of specimen. A. B. C. L.

1287. *Permanent Deformation of Metals.* **A. H. Leblond.** (Rev. de Mét. 20. pp. 250–256, April, 1923.)—A study of the effect of tension, compression, and combined tension and compression on metal. For the first two cases a square bar was used and the "slip square" produced on straining was studied. For the last case, the compression was applied hydrostatically, while the tension was simultaneously applied either in the same way or by a tensile testing machine. *Results:* (1) Metal stressed beyond its elastic limit is deformed by slipping along surfaces inclined at 45° to the direction of stress. (2) The slip takes place without rubbing and $T + P = E$, where $T =$ the tensile pull and $P =$ the hydrostatic pressure, which when simultaneously applied to the specimen causes it to elongate permanently by a very small amount, E being the elastic limit of the material. J. L. H.

1288. *The Elasticity of Sols and Gels.* **H. Freundlich** and **W. Seifriz.** (Zeits. phys. Chem. 104. pp. 233–261, March, 1923.)—A method which is devised for measuring the elastic properties, *i.e.* the modulus of elasticity and the unrelated property of elastic limit, of sols and gels consists in placing a nickel particle of 18 μ diameter in the interior of the colloid, subjecting to the action of a magnetic field from a pole terminating in a needle point immersed in the medium, and observing by means of a microscope the amount of displacement of the nickel particle and the position to which it returns on breaking the field, after being applied for definite short periods. In accordance with Hooke's law the displacement is proportional to the magnetic attracting force, or inversely proportional to the square of the distance between the pole and the particle. Measurements are made with different types of gelatin at concentrations up to 2 % with water and with distances between the particle and the magnetic pole which varied between 0·2 and 9 mm. The highest elastic limit, or maximum reversible displacement, is obtained at concentrations of from 0·7 to 0·8 per cent., which is in the neighbourhood of the transition point from sol to gel. Marked variations of the values are obtained in different parts of the gel, indicating heterogeneity of the colloid structure. This phenomenon, which is confirmed by other observations, such as the irregular path followed by a falling sphere, and also in the microscopic observation of irregularities of direction and speed of motion of the nickel particle, indicates the presence of areas of from 18 μ to 36 μ diameter of a different structure from the remainder of the gel.

The modulus of elasticity increases steadily and rapidly with increasing concentration of gelatin, but no abrupt change accompanies the transition from sol to gel. Considerable differences are obtained with different types of gelatin. A higher elasticity and lower elastic limit is shown on the surface than in the interior of the sol or gel. Sodium stearate solutions have a concentration function of elasticity and elastic limit similar to that of gelatin. A solution of sodium stearate of 0·05 N. concentration has, for instance, marked elastic properties, though its viscosity is only slightly higher than that of water. Sodium oleate solutions, even at high concentrations and viscosities, are, however, non-elastic. Albumin is characterised by very high elastic limit but low elasticity. Sols of vanadium pentoxide and of benzopurpurin containing barium chloride are elastic, but ferric-oxide sol is non-elastic. A concentrated solution of para rubber is elastic at the surface but not in the interior. Glycerine and a saturated sugar solution are completely non-elastic. In viscosity determinations the values obtained may be modified by elastic effects. J. N. P.

1289. *Rigidity of Gels.* **F. Michaud.** (Ann. de Physique, 19. pp. 63–80, Jan.–Feb., 1923.)—Since the publication of Schwedoff's researches (J. de Physique, 8. p. 341, 1889; 9. p. 334, 1890; 1. p. 49, 1892. See also J. Colin, Comptes Rendus, 116. p. 125, 1893) this subject appears to have received but scant attention. His method was so delicate that attempts to reproduce his experiments have failed. The author's method is simpler and has demonstrated the inaccuracy of certain views hitherto held concerning the mechanics of gels. The hot gel, introduced into a horizontal tube, is left to cool and adheres to the tube. A difference of pressure between the extremities of the tube, provided it be not excessive, produces elastic deformation. A relation may be established between P the difference of pressure, l the length of the tube, R its interior radius, X the displacement of the molecules at the axis and μ the modulus of rigidity of the gel. Let us mentally isolate a cylinder of radius $r < R$, coaxial with the tube. The resultant of the forces applied to the ends of this cylinder is $\pi r^2 P$. Equilibrium is maintained by the tangential forces generated by the deformation of the medium. Let x be the displacement of a point on the surface of the cylinder starting from the position of equilibrium. The angle of cleavage is: $\frac{dx}{d(R - r)} = -\frac{dx}{dr}$. The tangential force per unit of surface is $-\mu\frac{dx}{dr}$. We thus have: $\pi r^2 P = -2\pi r l \mu\frac{dx}{dr}$. Simplifying and integrating from 0 to R we get: $\mu = \frac{PR^2}{4Xl}$. Observation verifies this formula. It is easy to measure P, R, and l. To ascertain X, particles of gamboge or purified animal charcoal are placed in suspension in the gel. The apparatus is similar to the micromanometer described in the "Annales de Physique," 17, p. 382, 1922. To study very dilute gels the ends of the tube are connected with the lower apertures of two flasks of wide section. The apparatus is half filled with the hot solution which is left to cool for at least six hours. To produce a very small known difference of pressure it is sufficient to add to one of the flasks a known volume of solution. Fifteen aqueous solutions of gelose were examined, of concentrations regularly graded between 0·4 and 6 per mil, at temperatures between 14° and 15°. Three tubes of different calibre were used (i: $l = 19 \cdot 3$ cm., $r = 0 \cdot 485$ mm. ii: $l = 18$ cm., $r = 1 \cdot 09$ mm. iii: $l = 12 \cdot 2$ cm., $r = 1 \cdot 95$ mm.). The less rigid the gel the finer the tube employed. The author's observations of the behaviour of gels under mechanical strain, the results of which are given in a series of tables and curves, lead him to reject the contention of the physico-chemists that a solution of jellifying substance possesses a well-defined modulus of rigidity. Gels alone possess such a well-defined modulus. A dilute solution of gelose or gelatin when shaken becomes a suspension. After violent shaking the grains become very small and the result is a colloidal suspension. The viscosity of a gelatinous solution should therefore diminish with violent shaking. [See Hatschek, Koll. Zeit. 13. p. 88, 1913; Humphrey and Hatschek, Abstract 1190 (1916).] Schwedoff is in error when he says that a solution of gelatin, however dilute, always possesses rigidity, and that pure water has a like property. The author found a sharp line of demarcation. When the cohesion of the gel becomes too weak it can no longer hold in check the forces which cause the Brownian movement, and the elastic edifice is broken down. [See also Abstract 983 (1923).] E. F.

1290. *Calibrating Springs.* **C. Frémont.** (Comptes Rendus, 176. pp. 78–79, Jan. 8, 1923.)—In apparatus for measuring the intensity of a blow, for the same amounts of energy per blow, the amount of deflection of the spring used for making the measurement depends upon the velocity of impact. This is illustrated by four curves giving the results of experiments on a spring with four weights ranging from 0·35 kg. to 4·63 kg., the weights falling distances ranging from 2·857 to 0·216 metre, so that the amount of energy was 1 kilogram-metre in each case. C. A.

1291. *Accurate Bubble Meters for Small Gas Flow.* **T. Fuwa** and **G. A. Shattuck.** (Indust. and Eng. Chem. 15. pp. 230–231, March, 1923.)—A very simple and accurate form of meter is described. The main current of gas is "shunted" through a bubble counter and collected in a graduated jar while the main current flows through a second series of bottles, so as to stabilise the flow. The effects of different-sized nozzle tips upon the accuracy were investigated, and it was found that tips having an internal diameter of 8 mm. gave the most reliable results for rates of flow between 30 and 180 c.c. per minute. F. J. B.

1292. *Bifilar Pendulum and Large Amplitudes.* **H. S. Uhler.** (Optical Society of America, J. and Rev. Sci. Inst. 7. pp. 263–274, March, 1923.)—The object is to derive a convergent series for the period of the bifilar pendulum corresponding to any feasible finite amplitude. A set of rigorous equations are given leading to a hyperelliptic integral as formula for the period. This integral is expanded into two related series which depend on a fundamental series, the law of development of which is evident. Numerical illustrations are given. P. E. S.

1293. *Registration of Time by an Electrical Pendulum.* **H. Chrétien.** (Comptes Rendus, 176. pp. 882–885, March 26, 1923. Rev. Gén. d'Él. 13. pp. 653–654, April 21, 1923.)—This is a device for illuminating at a given instant a dial marked into 200 divisions. The illumination is produced by transmitting the light from discharge knobs through a collimator to a mirror attached to a pendulum and thence to the dial. By this method time can be registered to a thousandth of a second. P. E. S.

1294. *Wireless Time Signals.* **E. A. Thrum.** (Roy. Astron. Soc., M. N. Geophys. Suppt. 1. pp. 55–58, Jan., 1923.)—A self-heterodyning circuit is fitted with a relay, which causes a series of dots so arranged as to approach gradually the incoming time-signal dots. The time is read at the coincidence of the two series. This is much superior to the usual "eye-and-ear" method. W. A. R.

1295. *A Theory of the Viscosity of Liquids.* **C. V. Raman.** (Nature, 111. pp. 532–533, April 21, and pp. 600–601, May 5, 1923.)—A theory of the viscosity of liquids is developed on the supposition that, in a liquid, momentum is transferred partly owing to the diffusion of molecules between parts of the medium in relative motion, as in a vapour, and partly in the form of transverse elastic waves as in a crystal. The effective viscosity of a liquid is determined by the relative magnitudes of these two effects. By the application of Boltzmann's distribution law, and using Chapman's value of Sutherland's constant, the relation

η(liquid) $= \eta$(vapour)$\epsilon^{5E_3/RT}$, where η indicates the respective viscosities, E_3 is an energy constant deducible from the value of the viscosity of the vapour at various temperatures, and ϵ, R, and T have the usual significance, is deduced. It is shown that this relation affords values of the viscosity of liquid benzene between about 8° and 73° C. agreeing with experimental values to within 0·2 %. In the second note, the author advances certain thermodynamical considerations indicating that the supposition that the liquid state of aggregation is a composite one is *prima facie* a reasonable one. J. S. G. T.

1296. *Flow of Liquids into Capillary Tubes.* **C. H. Bosanquet.** (Phil. Mag. 45. pp. 525–531, March, 1923.)—The motion of a liquid flowing into a horizontal evacuated capillary under the influence of a constant head is examined, and an expression is obtained which is rigorous if Poiseuille's law holds. The equations are extended to the case of two fluids in contact, and an approximate solution is obtained. Similar formulæ are deduced for the case of a liquid flowing into an inclined tube. A. D.

1297. *Viscosity, Neutralisation, and Isomorphism.* **L. J. Simon.** (Comptes Rendus, 176. pp. 437–440, Feb. 12, 1923.)—Changes in viscosity caused by neutralising soda solutions with phosphoric or arsenic acids. Monosodic phosphate presents a minimum, trisodic a maximum viscosity. In aqueous solutions of the same molecular concentration, isomorphous substances modify the viscosity of water in the same manner, at a given temperature; a limiting law, most nearly obeyed at the smallest concentrations. A. D.

1298. *Apparatus for Admitting Gas into a Vacuum.* **J. B. Johnson** and **H. W. Weinhart.** (Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 175–177, Feb., 1923.)—A long vertical **U**-tube connects a large bulb, in which a small sealed bulb containing the gas is placed, with the apparatus into which a measured quantity is to be introduced. At the bottom of the apparatus side of the **U**-tube an adjustable mercury reservoir is attached; the lower part of the bulb side of the **U** is a capillary tube, which projects into an enlargement of the tube, about half-way up, to which a second adjustable mercury reservoir is connected. After the upper part of the apparatus on both sides has been evacuated the gas is released from the small containing bulb by letting a steel ball drop on the seal, and expands into the large bulb; mercury reservoir (1) is manipulated until the capillary tube is nearly filled with mercury, and then the reservoir (2) is raised until mercury flows into the enlargement of the **U**-tube, and encloses a small volume of gas in the upper part of the capillary tube; this is then driven over to the other side of the **U**-tube and so introduced into the apparatus where is is wanted. H. N. A.

1299. *Apparatus Giving the Instantaneous Direction of the Wind.* **Huguenard, Magnan,** and **A. Planiol.** (Comptes Rendus, 176. pp. 663–666, March 5, 1923.)—A hot-wire anemometer, measuring the amplitude and period of the variations in the speed of the wind, and capable of recording pulsations of less than one-tenth of a second duration, has already been described. [See Abstract 1018 (1923).] The present is a companion instrument for recording variations of wind-direction, and is also of the hot-wire type, consisting of two lengths of platinum wire heated electrically, and placed symmetrically on either side of a wooden obstacle exposed to the wind. The wires are connected in parallel in the electric circuit, a differential galvanometer being so included that the deflection is zero when the wind strikes the obstacle symmetrically, thus cooling both wires equally. When, however, the wind is inclined to the plane of symmetry, one wire is more protected than the other, they are unequally cooled, and the galvanometer is deflected. A device is included for rendering the deflection of the galvanometer, for a given inclination of the air-current, independent of the instantaneous speed of the latter. The instrument records photographically on the same sheet as the instrument for wind-speed and a specimen record from the two is reproduced. M. A. G.

1300. *An Optical Altitude Indicator for Night Landing.* **J. A. C. Warner.** (Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 225–229, March, 1923.)—The instrument described is the Jenkins night altitude indicator. Two downward beams of light are employed, one of which can be canted in their common plane. The beams throw distinctive light spots on the ground (or water). When the spots are made to coincide, the angle between the beams gives an indication of the altitude. In practice, two fixed parallel beams are used, one for low, and the other for higher altitudes. A diaphragm in the path of the canting beam is so interconnected with the canting mechanism that the light spot cast by this beam takes the form of a number (*e.g.* 50) representing the altitude. This number is also indicated on an illuminated scale in view of the pilot. If the canting beam is set for a given altitude, the position of its light spot with respect to the spots cast by the fixed beams gives a further indication of altitude. C. A. B.

1301. *Meteorology and the Non-Flapping Flight of Tropical Birds.* **G. T. Walker.** (Cambridge Phil. Soc., Proc. 21. pp. 363–375, Feb. 8, 1923.)—The writer in referring to the published results of Dr. Hankin's observations, deplores the absence of meteorological information, and therefore sets out to discuss briefly the known air movements in tropical countries, before finally considering the relation of these to Dr. Hankin's results. A number of facts, and observation results of the temperatures and velocities of the air at various heights in India, are given. The mechanical properties of birds and aeroplanes, namely, the lift, drift, and gliding incidences are then discussed, and a discussion is made of the usually accepted explanations of the gliding flight of birds in the light of the meteorological facts obtained. A. W. J.

1302. *Flying Fishes and Soaring Flight.* **E. H. Hankin.** (Cambridge Phil. Soc., Proc. 21. pp. 421–423, Feb. 8, 1923.)—If the span of the more efficient soaring animals is plotted against the wing loading, a very regular curve is obtained, indicating that the larger the bird the greater is the wing loading. Flying fishes have a much greater loading for their span than any other, and it is concluded, from the fact that their flights range from 60 to 400 metres, they must be about the most efficient of existing soaring animals in respect of weight carrying in a horizontal direction. The lateral instability of these fishes under certain conditions of sunlight and sea-smoothness is mentioned, and in view of the efficiency of the flying fish reference is made to its wing construction. The author concludes by indicating the probable utility of a study of the flying fish, as a guide to attempts at achieving artificial soaring flight. A. W. J.

1303. *On the Air Brake used by Vultures in High-Speed Flight.* **E. H. Hankin.** (Cambridge Phil. Soc., Proc. 21. pp. 424–425, Feb. 8, 1923.)—A short account is given of the modes in which the wings of vultures are used when landing at low and at high speeds, there being two distinct methods employed. For low-speed glides, the bird gradually rotates its wings so that just before perching their surface lies almost at right angles to the direction of flight; the speeds in this case do not exceed 40 m. per sec. For high-speed landings, the wings are flexed in camber at the metacarpal joint so that the incidence is approximately zero. Hankin discusses the reasons why such flexing should check the speed, and refers to Lilienthal's investigations on models of the wings of soaring birds, when using a whirling-arm for his tests. He disagrees with Lilienthal's conclusions as regards the eddies formed under the arched wing, from the point of view of the differently cambered sections of the live and dead bird's wing, and concludes that the eddies formed by the cambered wing occur at large positive incidences, and absorb a considerable amount of energy, which results in the observed braking effect. A. W. J.

1304. *New Methods of Crystal Analysis, and their Bearing on Pure and Applied Science.* **W. H. Bragg.** (Roy. Soc. Arts, J. 71. pp. 267–276; Disc., 276–277, March 2, 1923.)—In illustrating the symmetry relations of crystals containing molecules, half of which are mirror images of the others, a number of simple pairs of models was used, roughly representing pairs of shoes. One corner of a rectangular board was cut off, and at the other end a square board, the side of which was equal the shorter side of the rectangle, was nailed on to represent the heel of the shoe. A diagram is given showing two pairs of such shoes, placed heel to heel, representing the structure found for resorcinol, which has four molecules in the lattice cell. A drawing of the crystal is given, which as a result of this internal structure is symmetrical about each of two planes that meet at right angles in the axis of the crystal; there is no symmetry about a plane perpendicular to the axis, the two ends of the crystal having different forms. If the crystal is warmed, one end becomes positively electrified and the other negatively. The paper contains a better photograph of the model of the structure of tartaric acid than those contained in Astbury's original paper on this substance. Some remarks are made on the possible future value of X-ray methods in industrial problems; Westgren's work on the α, β, γ, and δ forms of iron, Carpenter's on crystals of aluminium, and the proof that kaolinite, though in the form of a very fine powder, shows a crystalline structure, which disappears when the temperature is raised to a certain point, are mentioned in this connection. H. N. A.

1305. *A Survey of Existing Crystal Structure Data.* **R. W. G. Wyckoff.** (Frank. Inst., J. 195. pp. 183–210, Feb.; 349–365, March, and pp. 531–552, April, 1923.)—Space group results permit the detailed consideration of all the atomic arrangements possible for a crystal, and give an opportunity of choosing the data to be determined experimentally in such a manner that they will decide which of these arrangements is correct. By this method of procedure it becomes possible either to deduce a unique solution, or else the structures which are possibilities are determined. The author surveys the subject, giving the results obtained for a large number of crystals, with a bibliography containing 151 references, including a large number dated 1922. He divides the crystals treated into four classes: Class IA, where all possible arrangements have been considered; IB, where space group data have been used to pick out a structure, but not to define all that may be possible; IIA, possible arrangements which, in spite of the incompleteness of their determination, are almost certainly correct; IIB, all other crystals studied. It is necessary to consider not only the amount of data in each case; but also their usefulness, and a relatively large number of qualitative considerations is more valuable. Laue photographs give the most valuable single method; powder experiments give reflections from planes of many crystal forms; this very advantage may introduce uncertainty in the choice of indices of the reflections observed with crystals of low symmetry; there is also a danger due to possible crystalline impurity in the powder; the spectrometer method, using an ionisation chamber, is open to grave error, as unless particular care is taken reflections from faces other than that investigated may yet get into the detecting chamber, and give either false readings of intensity or spurious reflections. All three methods, however, have their value, and also that in which the spectrometer effects are photographed. The author is pessimistic with regard to the work which has been done on organic compounds, only one of the few that have been measured, sodium acid acetate, is cubic, and has been subjected to the detailed treatment that the theory of space groups makes possible; even here the structure has proved too complicated for complete elucidation. H. N. A.

1306. *Crystal Structure of the Alums.* **R. W. G. Wyckoff.** (Am. J. Sci. 5. pp. 209–217, March, 1923.)—Laue photographic measurements by Terada, and an extended spectrometric study by Vegard and Schjelderup, were used by the latter authors in assigning a complicated structure to the alums. Niggli, from the same measurements, derived an atomic grouping corresponding to the space group $\mathrm{T}h^2$. Some measurements by the author on a Laue photograph of potassium aluminium alum pointed to T^6 rather than $\mathrm{T}h^2$; and the present investigation was undertaken to decide matters. A Laue photograph of potassium aluminium alum reproduced in the original paper is distinctly of hemihedral character; and the space group must, therefore, be either T or T*h*; a distinction between the space groups having these symmetries should be possible from a study of the reflections from planes having one index zero. With $\mathrm{T}h^2$ odd order reflections will be missing for planes $\left\{0kl\right\}$, where k is even and l is odd; $\mathrm{T}h^6$ will have no odd order reflections from planes $\left\{0hl\right\}$, where both h and l are odd; measurements on Laue photographs of potassium aluminium alum and ammonium aluminium alum indicate that the space group is $\mathrm{T}h^6$. Measurements with the X-ray spectrometer do not agree with this, as odd order reflections from the above planes appear to be obtained. The author has examined the point spectrographically; and comes to the conclusion that secondary spectra of considerable intensity are present, and that it is probable that reflections from other planes were received in the ionisation chamber during the spectrometer measurements, and gave results which were attributed to odd orders of the principal spectrum. The alums thus furnish a striking practical illustration of the inability of the unaided spectrometer to serve as a faithful basis for the determination of the structure of crystals. There are four molecules of the composition $R'R'''(SO_4)_2 . 12H_2O$ in the crystal unit; and the positions of the K or N atoms the Al and S atoms are given, using the nomenclature of Niggli. The sulphate O atoms cannot all be arranged in the same way, since there are not 32 positions available. Positions are assigned which are alike for three of the four atoms in SO_4 and different for the fourth. The 48 water-oxygen atoms have to be divided into two groups, and the H atoms into four other groups of generally equivalent positions. The 16 ammonium H atoms have to be divided into two groups of eight like atoms. This places the atoms on body diagonals, two on either side of an N atom. From a chemical standpoint this seems improbable; and it is suggested that these atoms may not have a symmetry which conforms to that of the crystals as a whole. H. N. A.

1307. *Structure under X-Rays.* **F. Kirchner.** (Ann. d. Physik, 69. 1. pp. 59–80, Oct. 19, 1922.)—With a special X-ray tube and the use of Seemann and Bohlin's focusing method for powdered crystal, an increased accuracy is attained with shorter times of exposure. Electrolytic deposits of Cu, Pb, Fe are crystalline, even under minimal current-strengths; platinum sponge is not. Aluminium leaf may be fibrous. The transition from non-magnetisable to magnetisable nickel steel (at 25 %) is examined; the latter contains more crystallite. The variation of the lattice-constant with the percentages in gold-copper alloys is determined. A. D.

1308. *The Normal Orbits of the Series Electrons of the Alkalies.* **A. T. van Urk.** (Zeits. f. Physik, 13. 4. pp. 268–274, 1923.)—Schrödinger has recently shown [see Abstract 1760 (1921)] that the apparent failure to enumerate the S-term quantum number is to be explained on the hypothesis that the outer electron penetrates the inner shells of the atom. Starting from a diquantic octet shell, he calculates the radius of the shell to be 0·614 a_0 (where a_0 is the radius of the innermost H-orbit). To enable computation he substitutes the effect of the shell upon the series electron by a spherical shell with uniform surface layer. The orbit can then be regarded as composed of Kepler ellipses, and the necessary calculations are made and included in the present paper, which then is concerned with necessary modifications of the formulæ. Tables of corrections are included, and data for the alkali metals given. The paper is mathematical throughout. H. H. Ho.

1309. *Structure of Silicon.* **H. Kuestner** and **H. Remy.** (Phys. Zeits. 24. pp. 25–29, Jan. 15, 1923.)—Silicon preparations of different origin were examined with regard to the proportion of SiO_2 contained in them, their power of chemical reaction, size of particles determined microscopically and by measurement of rate of sedimentation in alcohol, and their crystal structure determined by means of X-rays. Specimens with between 2·5 and 30 % of SiO_2 all showed the diamond structure, as discovered by Debye and Scherrer; "amorphous silicon" containing 72 % SiO_2 showed only the spectrum of quartz. There was in no case any evidence of the existence of amorphous silicon; difference of chemical reactivity was shown to be due to the amount of surface exposed, being greater with fine particles than with large ones. The edge of the elementary lattice cell (100) of silicon measures 5·4204 ± 0·00016 Å. H. N. A.

1310. *The Viscosity and Molecular Dimensions of Hydrogen Selenide.* **G. J. Smith.** (Faraday Soc., Trans. 18. pp. 302–307; Disc., 307–309, Feb., 1923.)—A. O. Rankine has recently called attention to the relations between the molecular dimensions of argon and the gaseous hydrides, the molecules of which have the same nuclear charge [Abstract 2377 (1922)]. By obtaining the necessary data for H_2Se the author has completed the information necessary for a similar study of the series Kr, HBr, H_2Se, and AsH_3. When the mean collision areas are plotted against the number of hydrogen atoms in the molecule a smooth curve is obtained, which shows that, as the H atoms multiply, the distance of each H nucleus from the centre of the molecule increases more and more rapidly. Sutherland's constant could not be determined by measuring the rate of variation of the viscosity with temperature, as the H_2Se decomposed a little above atmospheric temperature. Rankine, however, has shown that, for several groups of gases having similar chemical constitution and corresponding places in the periodic table, there is a simple proportionality between Sutherland's constant and the critical temperature. Taking advantage of this, the observed viscosity of H_2Se has been reduced to zero, $\eta_0 = 1{\cdot}55 \times 10^{-4}$ c.g.s. units, and the mean collision area is found to be $\bar{A} = 0{\cdot}86 \times 10^{-15}$ cm.^{2}. In the *discussion*, **A. O. Rankine** stated that according to Sutherland, his constant, which had the dimensions of a temperature, was a measure of the work required to separate two molecules originally in contact. The critical temperature is a measure of the linear kinetic energy of the molecules of the gas. The ratio of the two quantities turns out to be about unity, and this rather suggests that below the critical temperature the kinetic energy is not, on the average, sufficient to separate two molecules completely after they have come into contact. On the other hand, above the critical temperature the kinetic energy is more than sufficient to cause the molecules to break away from one another. This applies strictly only to the inert gases, for which the ratio c/T_c is almost exactly unity. For most other gases it is about 0·8; but even here the suggested physical interpretation has an approximate validity. H. N. A.

1311. *Dimensions of the Atomic Nuclei and α, H^+, β, and γ Radiations.* **M. C. Neuburger.** (Ann. d. Physik, 70. 2. pp. 139–152, Jan. 31, 1923.)—The magnitude relations of the atomic nuclei can be calculated from the recent experimental results of Rutherford and Chadwick [Abstract 918 (1922)], and the mathematical conditions for the energy relations during nuclear division. The velocity of the H^+-particle is the resultant of v_K, the velocity with which it is moved to the periphery of the nucleus by the colliding α-particle, and the additional velocity v_A imparted to it by the field of force of the atom; v_A is a function of the atomic number N and the radius of the nucleus. The kinetic energy corresponding to v_A is $m_H v_A^2/2 = Ne^2/r$, so that the radius of the nucleus is $r = 2Ne^2/m_H v_A^2$.

If the observed value of v is used instead of v_A a lower value for r is obtained and this gives a very low lower limit for the nuclear radius in the elements split up by Rutherford. A higher value for the lower limit of r is obtained from the consideration of the fact that the α-particles from radium-C′ are apparently able to penetrate into the nuclei of all the elements except hydrogen. From somewhat similar energy considerations to those given above, the expression $r = 3 \cdot 4814\, N x\, 10^{-14}$ is arrived at for the lower limit, though in a supplementary note it is stated that $r = 3 \cdot 4814 \times 10^{-14}$ must be regarded as an upper limit in the case of hydrogen, since the α-particle cannot penetrate into its nucleus. By the relativity theory the lower limit for r in the case of hydrogen is $1 \cdot 01 \times 10^{-16}$. Another method of attack, in the case of radio-active elements which emit α-rays, is to calculate the lower limit for r from the velocity with which the α-particles are ejected; the values obtained are somewhat larger than those calculated from the above equation, and they show periodic variations of similar character through the different radio-active series. A certain amount of information can also be obtained from the elements which emit β-rays, though the mathematics is more difficult, as owing to the high velocity of the electrons relativity has to be taken into consideration. In some cases, too, the β-ray emitted does not come directly from the nucleus; but the movement of an electron from one quantum level to another in the nucleus produces a γ-ray, which transmits its energy to a circumnuclear electron, thus complicating matters. The upper limit for r in radium is $67 \cdot 0 \times 10^{-12}$, and the lower $5 \cdot 32 \times 10^{-12}$; the numbers for radio-thorium being 150×10^{-12} and $4 \cdot 86 \times 10^{-12}$. The author proposes to consider in a future paper the energy levels inside the atomic nucleus, and the quantum transferences between the disintegrating atoms and the resulting atoms, or the quantum theory of radio-active change. H. N. A.

1312. *The Quantification of Rotating Molecules.* **H. A. Kramers.** (Zeits. f. Physik, 13. 6. pp. 343–350, 1923.)—It has been assumed that the resultant electron impulse of a molecule vanishes (asymmetric force-free rotor); or molecules with two atoms have been dealt with, in which the electron impulse is parallel to the line joining the nuclei. The present paper deals with the more general case, where the electron impulse has *any* direction. The problem of a rigid body, in the interior of which a symmetrical rotor can revolve about an axis connected with the body, is investigated, and the quantum relations are studied. The results obtained are then applied to molecular rotations, where, on account of the minute mass of an electron, as compared with the atomic nucleus, the general equations obtained can be greatly simplified. If 2E is the doubled energy of rotation; A, B, C the principal moments of inertia of the molecule; p, q, r the instantaneous angular velocities of the molecule about the principal axes; τ_1, τ_2, τ_3 the direction cosines defining the direction of the axis of revolution of the electron with respect to the above axes; P, Q, R the total components of the total impulse moment of the molecule; S the constant impulse component of the electron, parallel to its axis of rotation, and I the total impulse of the molecule, then $2E = Ap^2 + Bq^2 + Cr^2$; $P = Ap + S\tau_1$; $Q = Bq + S\tau_2$; $R = Cr + S\tau_3$; $2E = (P - S\tau_1)^2/A + (Q - S\tau_2)^2/B + (R - S\tau_3)^2/C$ and $I^2 = P^2 + Q^2 + R^2$. The quantum states are obtained by making I a whole multiple of $h/2\pi$ and giving E values, which are derived by means of the general theory; it is not, however, possible to quantify S, as is done in the general theory, this is apparently owing to the approximations made use of in dealing with the molecule. The assumption that the electron impulse rotates as though rigidly connected with the molecule will certainly be correct in many cases. In the case of band spectra we have to do with movements between stationary states, where not only the quantum numbers relating to the rotation of the molecule and the vibrations of the nuclei, but also those relating to the path of one of the electrons are altered, and we must be prepared to meet with cases where the coupling of this "photo-electron" with the molecular ion is not strong enough to cause it to rotate with the molecule like a rigid body, as in the above theory. H. N. A.

1313. *The Quantum Theory of the Hydrogen Molecular Ion.* **K. F. Niessen.** (Ann. d. Physik, 70. 2. pp. 129–134, Jan. 31, 1923.)—The author has arrived independently at results similar to those of W. Pauli, whose paper, "A Model of the Hydrogen Molecular Ion," appeared in the Ann. d. Phys. in August, 1922. The author was able to obtain the conditions for stability of the electron orbit, and of nuclear equilibrium, both for symmetric and asymmetric models. For the model $n_1 = 0$, $n_2 = 1$, $n_3 = 1$, the energy is found to be $- 0·516\,h$R, R is Rydberg's constant; the nuclear distance is $5·53\,a_1$, a_1 is the shortest wave-length of the H atom; the eccentricity of the ellipsoid is 0·780, the possible error in the energy being one unit in the last decimal place. The author has also calculated out in the same way all models in which $n_1 + n_2 + n_3 \leqq 6$, including the asymmetrical ones, and gives the main results of this very laborious piece of work. Some of the asymmetric models are stable, but the nuclear distance is greater than $80a_1$. The combined energy and the nuclear distance has been calculated for 27 of the symmetrical models, the remaining eight are found to be impossible; the results are given in a table. By means of Bohr's principle of correspondence the possible frequencies are worked out, and a table gives these, together with the initial state and final state for each; as an example, initial state $n_1 = 0$, $n_2 = 3$, $n_3 = 2$, final state $n_1 = 0$, $n_2 = 3$, $n_3 = 1$ gives $\nu = 10{,}950$. The author has obtained formulæ, in the case of nuclei which do not rotate, for the probability of passage from one state to another, by means of which it should be possible to calculate the relative intensity of the spectral lines. The voltage necessary to break up a molecule into an ion and an electron has been calculated for different states of the ion; also those required to break up the ions into their component parts. For small quantum numbers there is no ionisation voltage of 30·5 volts. This voltage therefore cannot be ascribed to an ion, though Franck has assumed this; 30·5 volts would correspond to an ion with zero energy, such an ion can never be stationary. It appears that Franck gave up his first view, that the molecule is broken up into all of its four components with a voltage of 30·5, too soon. H. N. A.

1314. *Whittaker's Quantum Mechanism in the Atom.* **H. A. Lorentz.** (K. Akad. Amsterdam, Proc. 25, 9 and 10. pp. 414–422. 1923. In English.)—Recently Whittaker [see Abstract 2056 (1922)] has proposed an interesting model by means of which the quantum properties of the atom can be accounted for to a certain extent, the model showing in the first place how it may be that, in the collision of an electron against an atom, the former loses either no energy at all, or just a definite amount of it. The present author now offers some remarks about the action between an atom and an electron as it would be according to Whittaker's views. The latter's theory takes the simplest form when it is assumed that there are not only electric but magnetic charges, and that by the introduction of these into the fundamental equations, the parallelism between the electric and magnetic quantities can be clearly brought out. Whittaker's result for the motion of the electron is confirmed, but in his calculations the motion of the electron has only been considered along the axis of the ring; this result is now generalised. A criticism is given of the hypothesis of magnetism existing independently of electric currents. The author justly points out that Whittaker does not emphasise the special form of his model, but merely uses it to obtain a satisfactory system of equations, and to show the possibility of a sharp criterion by means of which it can be decided whether an encounter is effective or otherwise. The final paragraph deals with the generalisation of the model. H. H. Ho.

1315. *Application of the Quantum Theory to the Problem of Atomic Structure.* **N. Bohr.** (Zeits. f. Physik, 13. 3. pp. 117–165, 1923.)—In attempting to connect the quantum theory with the classical theory of electrodynamics, it is natural to assume that the movements in the stationary states (Bohr orbits) can be described with considerable approximation by means of electrodynamical laws, if reactions connected with the emission of radiation are omitted. Starting from this assumption, the author gives an account of his former mathematical work on the subject [Abstract 266 (1922)], emphasising the importance of the adiabatic principle and the correspondence principle. When an electron collides with a positive atom-ion, and union takes place, it is possible to use the correspondence principle to show that harmonic components with all possible frequencies may be produced; but with a sharp limit on the high wave-length side; this accounting for the so-called continuous spectrum observed; this limit is not accounted for by the classical theory. The author does not agree with Einstein's view that the radiation energy quantum, as it travels through space, is concentrated in a small volume, and when it is absorbed is taken up as a whole. Interference phenomena cannot be explained in this way, and it becomes impossible to understand the meaning of the frequency ν, which is of such importance in the quantum theory; on the other hand, Whittaker's atomic mechanism seems to indicate the direction in which a complete and comprehensible picture of the phenomena may be found; in the present stage of the quantum theory, however, it cannot be regarded as particularly helpful. Instead of considering the radiation as taking place in all directions, in empty space, the author considers the field of radiation as a closed space with reflecting walls, and studies the reactions between the atoms and radiations in this space. In dispersion phenomena the reaction of the atom on the radiation is closely connected with the unknown mechanism, which is responsible for sending out radiation when a transference between stationary states takes place. Absorption spectra depend largely on the scattering of the wave train, and not on real absorption; observations on resonance radiation give more directly the interchange between the field of radiation and the atom. Difficulties arise when the laws of conservation of energy and of impulse are directly employed to obtain information as to the nature of the radiation process. In the case of the electromagnetic waves of wireless telegraphy we have systems which depend on the mutual actions of large numbers of atoms, and the quantum numbers, if these can be spoken of in such a case, are very numerous. It is not probable that the correspondence principle can be used here; or that there is an assymptotic agreement between the statistical result of the quantum theory and of the classical theory. It appears, then, impossible to derive results of value to the quantum theory from such phenomena. H. N. A.

1316. *Phase Relations in the Bohr Models for Atoms and Molecules.* **M. Born** and **W. Heisenberg.** (Zeits. f. Physik, 14. 1. pp. 44–55, 1923.) —During an investigation of the possible quantum models for the hydrogen molecule, it became manifest that in the application of quantum conditions to the movements of electrons of atoms which mutually effect each other, definite phase relations must arise. This problem is now investigated further, and it is found that such phase relations must appear between the motions of the electrons in one and the same atom. Bohr has already discussed such a possibility for the explanation of the doublets in the case of helium. The present authors now conclude that for every atom in normal condition the whole system of the electronic orbits is exact in phase, *i.e.* purely periodic. The mathematical method adopted is based on that of Poincaré and Lindstedt, which has been adapted by Born and Pauli [see Abstract 1955 (1922)] to the quantum theory; this has now been extended to the present case. The principal difficulties of the quantum theory in connection with this problem are discussed in the final sections. Only simple cases are studied in the paper which is entirely mathematical. H. H. Ho.

1317. *Atoms and Radiation.* **F. Skaupy.** (Zeits. f. Physik, 12. 3 and 4. pp. 184–188, 1922.)—Suggests a theory according to which radiation, quanta, etc., are not the product of single atoms, but are residual or resultant effects of aggregates of atoms in mixed phases, the resultant being affected by the impact or the movement of electrons. This will explain absorption and fluorescence, the emission of light by a gas, and the photoelectric effect; and it reconciles electrostatic and electrodynamic views. A. D.

1318. *A Model to Demonstrate the Distributions of Magnetons Round One or More Positive Nuclei.* **A. P. Laurie.** (Roy. Soc. Edinburgh, Proc. 42. 3. pp. 352–361, 1921–1922, and 43. 1. pp. 72–84, 1922–1923.) —A model is described consisting of a series of small coils mounted on a base. Most are fixed, but two are pivoted separately on a support, which is itself pivoted about its central point. With this apparatus the behaviour of two systems of magnetons spaced equally about positive nuclei is investigated. Two types of reaction are noted. Firstly, if the sense of the magnetic circuit round each ring of magnetons is the same, two magnetons will set themselves on each side of the line passing through the nuclei with their planes at right angles to it, thus tending to create a continuous magnetic circuit round the whole system. This is considered the equivalent of combination. If the magnetic circuits are in opposite senses the two magnetons concerned set themselves in the line joining the centres, and with their planes normal to it, and are then drawn bodily as a pair into the system, having the stronger magnetic field. If the magnetons also are subject to electrostatic force, this will leave the systems united electrostatically, but not magnetically, and it is suggested that this represents the state of affairs in a compound capable of ionisation. Several simple substances are discussed in this manner. A. Wh.

1319. *On the Theory of Generalised Quanta and the Balmer Lines.* **S. C. Kar.** (Phil. Mag. 45. pp. 610–621, March, 1923.)—The general principles governing the quantaic structure of phase-space were first given by Planck [see Abstract 1362 (1916)], and followed by somewhat different and simpler conditions laid down by Sommerfeld. These are discussed as a preliminary by the author, who then suggests a fresh standpoint, and develops it by reference to the particular cases of (1) the linear oscillator, (2) the rotator, (3) the ordinary Newtonian ellipse, and (4) the relativistic Newtonian ellipse. While they meet all the objections stated against Sommerfeld's theory, results are afforded identical with those of Planck and Sommerfeld in the first three cases, but at variance with both for the relativistic ellipses. The central idea is that of Planck, *viz.* the structure of phase-space must be on the basis of the integrals of motion, and the suggestion is made on theoretical grounds of statistics that the quanta integral in the case of one degree of freedom should be written in the form $\int_0^n \mathrm{T}\delta\mathrm{H} = nh$, and that in the case of Newtonian elliptic motion, both of the ordinary and the relativistic type, quanta integrals should be written in the forms $\int_0^n \mathrm{T}\delta\mathrm{H} = nh$, $\int_0^{n'} \Phi\delta p = n'h$ (where T is the periodic time, H the energy, Φ the complete azimuthal period, and p the angular momentum). The consequences of this theory are compared with those of Sommerfeld's and with the observations of Paschen on the Balmer lines of hydrogen, and it is shown that while the doublets and triplets receive no direct explanation, there being no splitting of energy as with Sommerfeld, the behaviour of the Rydberg number may be regarded as somewhat more satisfactory. Extension to n degrees of freedom may be made, provided the n first integrals of the motion are to hand of which one is necessarily the integral of energy. When the positional coordinates, which are canonical conjugates of the integration-constants treated as momenta, are obtained, the quanta-integrals are of the form above. It is evident that a quanta integral would tend to become infinite if the periodic time or the period of the positional coordinate is infinite, *i.e.* if the dynamical system in respect of that particular coordinate is not periodic. It would thus follow that quantaic changes of energy or momenta are a property of periodic or quasi-periodic motions, and that where there is no periodicity the energy changes or momenta changes must be gradual—a fact which will ensure a finite value for the quanta-integral. H. H. Ho.

1320. *On the Question of the Number of Radiating Atoms of Various Dimensions within Gaseous Hydrogen, Studied from the Point of View of Bohr's Atom Model.* **P. Lasareff.** (Phil. Mag. 45. pp. 430–432, March, 1923.)—The dimensions of the hydrogen atom calculated from Rutherford-Bohr's theory is determined by the radius a of an electron moving round the centre as: $a = h^2 r^2 T^2/4\pi^2 m e^2$, where h is Planck's const., m the electron mass, ϵ its charge, and T any whole number from 1 to ∞, representing the order of the electron's stable orbit. In the case of a single atom its dimensions are determined by the above formula. If there are many atoms, subject to mutual shocks, the dimensions of the electron's orbit cannot surpass a certain limit because of the mutual influence of the electrical fields of atoms, and experimentally it is possible to observe only spectral lines for which T varies from 1 to 15; orbits surpassing the last are impossible. Rarefaction of the gas, however, permits the maximum of the atom's dimension to increase, and, in star spectra, spectral lines of hydrogen have been found indicating the existence of atoms with an electron orbit of the order 33. The present paper, therefore, attempts to find out the relative number of atoms of gas radiating and possessing electron orbits of different orders. The relative quantities of atoms have been found having electrons displacing themselves from the 3rd, 4th, and 5th orbit to the 2nd, producing radiation of the first 3 lines of Balmer's series with wave-lengths $656 \mu\mu$, $486 \mu\mu$, and $434 \mu\mu$. For finding the energy ϵ of a definite spectral line, the spectrum of hydrogen in a Geissler tube has been spectro-photometrically compared with the intensity of Hefner's lamp, for which the energy distribution in the spectrum has been studied by Ångström. A brief experimental account is given. From the data, it is deduced that in a Geissler tube, radiating under the influence of an electric discharge and filled with hydrogen, most of the electrons causing the radiation move over from the 3rd orbit to the 2nd. The quantity of electrons springing from the 4th to the 2nd orbit is only 25 % of that 1st quantity, and, finally, only 17 % spring from the 5th to the 2nd orbit. The quantity of springing electrons thus decreases with increase of distance of the electrons from the centre. H. H. Ho.

1321. *Can Evidence For or Against the Theory of Relativity be Obtained by Observations of the Planets?* **J. Trousset.** (Comptes Rendus, 176. pp. 888–889, March 26, 1923.)—The author contends that planetary data, more especially those referring to the dimensions of planetary orbits, the masses of the planets Mercury and Venus, and the universal constant of gravitation, are not known with sufficient precision to enable the differences between the periods of revolution of planets to be calculated with the accuracy necessary to discriminate between results deduced by the application of the Newtonian law of attraction and the four laws suggested by J. Chazy in a recent communication [see Abstract 1342 (1923)], and which lead to the same result for the motion of perihelion as that given by the theory of relativity. J. S. G. T.

1322. *Introduction of an Electromagnetic Field into Einstein's Relativity Scheme.* **E. Reichenbächer.** (Zeits. f. Physik, 13. 4. pp. 221–240, 1923.)—The author finds that, by means of an asymmetric tensor, an electromagnetic field can be introduced into the Einstein scheme of relativity in a manner very similar to the introduction of a gravitation field. This is a simpler procedure than Eddington's method of introducing the asymmetric curvature tensor $\overset{*}{G}_{\mu\gamma}$ [Abstract 1001 (1921)], and very much less of an anomaly than Weyl's non-integrability hypothesis [Abstract 1274 (1919)]. The author expresses his indebtedness to Weyl for his conception of in-invariance and for his use, in this connection, of the quantities $F_{\mu\gamma}$ and F. G. W. de T.

1323. *The Ether.* **E. Wiechert.** (Phys. Zeits. 23. pp. 513–519; Disc., 519, Nov. 15 and Dec. 1, 1922. Paper read at Deut. Physikertag, Leipzig, Sept., 1922.)—A terse statement, not lending itself to abstraction, of the author's non-relativist views. A. D.

1324. *An Alternative Theory.* **C. H. Bickerdike.** (Phil. Mag. 45. pp. 456–463, March, 1923.)—Preliminary sketch of a theory, for moving bodies, that the propagation of oscillatory disturbances takes place only along the Faraday tubes. Its relation is given to the Michelson experiment and the Lorenz transformations, which latter become merely virtual or fictitious devices; and to Majorana's experiments, which the theory explains. A. D.

1325. *Field Excitation by Masses and by Charges.* **E. Reichenbächer.** (Phys. Zeits. 23. pp. 519–523, Nov. 15 and Dec. 1, 1922. Paper read at Deut. Physikertag, Leipzig, Sept., 1922.)—A discussion, not lending itself to abstraction, of the fundamentals of the relativity theory, as compared with the author's own published views. A. D.

1326. *Inertial and Heavy Masses.* **G. Mie.** (Ann. d. Physik, 69. 1. pp. 1–53, Oct. 19, 1922.)—The author endeavours to approximate the whole mathematical scheme of Einstein's gravitation theory as closely as possible to that of Newtonian dynamics, in order that the resemblances and differences in the conclusions derivable from the respective theories may be set forth in the simplest and most convincing shape. The author claims to have shown [Abstract 340 (1913)] that the classical concepts, of the accelerating forces of fields and the inertial resistance to acceleration of material particles, may be regained by making the one fundamental assumption that a material particle exists in its associated spatial domain in identically the same way as in a domain in which there is no field. This is practically the case in a gravitation field, provided Einstein's gravitational equations be admitted, but probably does not hold, except approximately, and then under definite limitations, in an electromagnetic field. Hence the ingress of quantum dynamics into the electromagnetic field. Einstein's equations are first brought into the author's scheme in which, according to his theory of matter, all fundamental physical laws can be arranged [Abstract 809 (1914)]. His method of calculating mechanical forces [l.c. (1913)] is then applied to the scheme thus extended. G. W. DE T.

1327. *Atmospheric Absorption at Mont Blanc.* **E. Bauer** and **A. Danjon.** (Comptes Rendus, 176. pp. 761–763, March 12, 1923.)—The paper discusses briefly two series of observations of the variation with zenith distances of the brightness of the sun, for three narrow ranges of wave-length, made with a Fabry and Buisson photometer and Wratten filters, at a high level station, Vallot (alt. 4347 m.), where absence of dust enables observations right down to the horizon to be utilised in this study of atmospheric absorption. Plotting the logarithm of the quantity of light transmitted against the mass of air traversed, the result, if the air behaved as a homogeneous absorbing medium, would be a straight line, the slope of which would give the absorbing power (log a) of the air for one normal atmosphere traversed. The actual curve obtained is hyperbolic in form, only approximating to a straight line between zenith distance 87° and the horizon. The following are the values given by this portion for log a and for $\lambda^4 \log a/(n-1)^{-2}$, which in Rayleigh's theory is constant:

λ.	$-\log_{10} a$.	$\lambda^4 \log a/(n-1)^2$.
$0{\cdot}629\ \mu$	$0{\cdot}0352$	$6{\cdot}35 \times 10^{-12}$
$0{\cdot}527\ \mu$	$0{\cdot}0595$	$5{\cdot}33 \times 10^{-12}$
$0{\cdot}482\ \mu$	$0{\cdot}0762$	$4{\cdot}84 \times 10^{-12}$

The departures of the numbers in the third column from a constant value are due to the additional effect of selective absorption to that of diffusion. The value $N = 59 \times 10^{22}$ is deduced for Avogadro's constant, assuming that selective absorption is negligible in the blue. The authors regard the departure of the remaining portion of the curve from a straight line as real, and advance a theory to account for it, which involves the assumption of the existence of a relatively thin absorbing layer at a height of about 150 km. M. A. G.

1328. *Rainfall Period Equal to One-Ninth the Sunspot Period.* **D. Alter.** (Kansas Univ., Sci. Bull. 13. pp. 17–99, July, 1922.)—This completes the investigation of this period described in previous papers [Abstract 1507 (1922)], using much longer records and data from the United States, Northern Europe, Central Siberia, the Punjab in India, Chile, South Australia, Jamaica, and Madagascar. It is concluded that this period exists, and that the relationship is not direct, but due to an unknown common cause. In purely continental areas minimum rainfall is connected with a maximum of sunspots, and in purely marine with a minimum of sunspots. A. W. L.

1329. *Penetrating Radiation at Wanikoi.* **W. Kolhörster.** (Zeits. f. Physik, 11. 6. pp. 379–395, 1922.)—Continuous observations were made on penetrating radiations at the Wanikoi Observatory (Lat. 40·8°; long. from Gren. 29°). The penetrating radiation shows a yearly period, with a maximum in summer and a minimum in winter, and gives a curve similar to a temperature curve. The daily period shows two waves. The effects of other influences, such as radiation from the earth, are considered, but such systematic errors affect the results only remotely. W. A. R.

1330. *Anchor Ice.* **W. J. Altberg.** (Roy. Meteorolog. Soc., J. 49. pp. 54–59, Jan., 1923.)—Observations on the River Neva and laboratory experiments show that water may remain in a slightly supercooled state even in the presence of the solid phase. Supercooling proceeds to a maximum during the first half of a period of supercooling, and then gradually decreases. Crystallisation proceeds most rapidly in the first half. The slight degree of supercooling would soon be abolished by the latent heat of crystallisation if the heat were not eliminated. Experiment and observation show heat cannot be radiated directly from the bottom, but is eliminated through the action of vigorous mechanical inter-mixture.

The occasional bottom freezing of the Neva is due to rarely occurring conditions causing a maximum heat loss. W. A. R.

1331. *Unsolved Problems of Cosmical Physics.* **W. F. G. Swann.** (Frank. Inst., J. 195. pp. 433–474, Jan., 1923.)—Quasi-popular discussion of the problems of atmospheric electricity, atmospheric conductivity, the maintenance of the earth's charge, the origin of the earth's magnetism, the secular and diurnal variations, the aurora, and gravitation. Objections weighed to the various solutions which have been proposed. A. D.

1332. *Algerian Earthquake,* 1922. **A. Hee.** (Comptes Rendus, 176. pp. 39–41, Jan. 3, 1923.)—Microseismic observations lead to a placing of the epicentre of the Algerian earthquake, Aug. 25, 1922, close to Cavaignac. This agrees with other determinations. The elements of the calculation are tabulated. W. A. R.

1333. *Oppau Explosion Waves.* **Dorothy Wrinch** and **H. Jeffreys.** (Roy. Astron. Soc., M.N., Geophys. Suppt., pp. 15–22, Jan., 1923.)—The observations of the seismic waves of the explosion of the Badische factory at Oppau, which occurred on Sept. 21, 1921, are collected and discussed. The results are used to determine equations for the transmission of seismic waves in a heterogeneous crust. W. A. R.

1334. *Seismology.* **H. Labrouste.** (Ann. de Physique, 19. pp. 5–62, Jan.–Feb., 1923.)—The paper gives a brief summary of the present state of the science and includes treatment of the chief types of seismograph, the interpretation of the records, and the tracing of paths of waves in the interior of the earth. W. A. R.

1335. *Periodicities of Jamaica Earthquakes.* **H. H. Turner.** (Roy. Astron. Soc., M.N. Geophys. Suppt. 1. pp. 31–50, Jan., 1923.)—Maxwell Hall deduced some 40 periods ranging from 12 to 13 days for the recurrence of Jamaica earthquakes, and these are shown to be multiples of a period of 21·00 minutes (0·0146 day). The intervals between the means of these periods are multiples of 0·01458435 day. The mean result for the fluctuation of the maximum gives a period close to 4 years. Other fluctuation periods are not well supported. W. A. R.

1336. *Propagation of Earthquake Waves.* **J. H. Jeans.** (Roy. Soc., Proc. 102. pp. 554–574, Feb. 1, 1923.)—The case of a gravitating compressible sphere, concentrically stratified, and with stress-strain relations of the type suggested by Rayleigh, is investigated with reference to free vibrations spreading out as waves from a centre at or near the surface. These vibrations are found to fall into two distinct classes, corresponding exactly to the primary and secondary waves of seismology. Investigation of the frequencies of these waves leads to the construction of an earth "spectrum." The Rayleigh surface waves are shown to be only an insignificant fraction of the total waves propagated in two dimensions only, so that their seismological importance is much diminished. Following up the suggestion that waves after completing a circuit of the globe act as a "trigger" on re-arrival at the epicentre, it is shown that a series of after-shocks with periods of 125·8 and 222·0 minutes could be accounted for. Some earthquakes appear to agree with this period, but it affords no basis for Prof. Turner's period of 21 mins. [See preceding Abstract.] W. A. R.

1337. *Influence of Mountains on Earthquake Shocks.* **O. Mengel.** (Comptes Rendus, 176. pp. 111–114, Jan. 8, 1923.)—The seismic disturbances in the Eastern Pyrenees, which occurred in the second half of 1922, reveal the effects of mountains on the propagation of earthquake waves. Mountain masses arrest or damp waves in proportion to their size. The older the geological formation the greater is the effect. Alluvium gives greater vibration than the bed-rock, and seismic resonance occurs wherever there is an abrupt change either in relief or structure. W. A. R.

1338. *Pamir Earthquake,* **1911,** *and Focal Depth.* **H. Jeffreys.** (Roy. Astron. Soc., M.N. Geophys. Suppt. 1. pp. 22–31, Jan., 1923.)—The formulæ derived for computing earthquake-wave energy differ considerably from Galitzin's. With regard to the earthquake at Pamir, Galitzin's calculation of the energy was 250 times too high, but this agreed with the energy set free by the impact of the falling mass on the ground. It is shown, however, that only 1/300 of the energy of impact would go into the wave, so the results still agree. Accordingly it can still be inferred that the wave was actually produced by the landslip. The observations of this earthquake, whose focus was at the surface, is compared with ordinary shocks occurring at various depths. No systematic difference was discovered that could be referred to depth of focus, and it is considered that the earthquakes occurring in ordinary tables originated at depths not greater than 120 km. W. A. R.

1339. *Depth of Earthquake Foci.* **H. H. Turner.** (Roy. Astron. Soc., M.N. Geophys. Suppt. 1. pp. 50–55, Jan., 1923.)—Galitzin, from observations on the angle of emergence of earthquake waves at Pulkovo, postulates three new critical surfaces at depths of 106 km., 232 km., and 492 km., in addition to the much lower surface of Wiechert. The author from his calculations of the relative depth of foci [Abstract 2220 (1922)] suggests that these collect about three surfaces, though the absolute depths are not given. If Galitzin's depths be assumed the velocities of waves can be revised. W. A. R.

1340. *Geothermic Gradient.* **F. Raspal.** (Comptes Rendus, 176. pp. 317–318, Jan. 29, 1923.)—Temperature records from a boring, 1700·40 m. deep, situated near Molières (Gard) are recorded. The gradient varies at different levels, being steepest at the surface (18·70 m.); and most gentle at a stage near the bottom (32·60 m. per degree). W. A. R.

1341. *Compressibility of Minerals and Rocks at High Pressures.* **L. H. Adams and E. D. Williamson.** (Chem. Soc., J. 195. pp. 475–529, April, 1923.)—The compressibilities of minerals and rocks under hydrostatic pressures of 12,000 megabars (equal to a depth of 40 km. below the earth's surface) are tabulated. The compressibility of the minerals falls off slightly with increasing pressure. Even in the case of igneous rocks the porosity affects the compressibility, but above 2000 megabars this factor has little effect. In general the compressibility of a rock that is holocrystalline may be calculated from that of the constituent minerals;

and the compressibility increases as the silica content decreases. The values given for compressibility and the known velocities of earthquake waves indicate on calculation that a basic or ultrabasic rock exists at a relatively small depth below the surface. [Abstract 510 (1919).]

W. A. R.

1342. *Corrections Required by the Theory of Relativity to the Durations of Revolution of Planets Given by the Newtonian Law.* **J. Chazy.** (Comptes Rendus, 176. pp. 666–668, March 5, 1923.)—In the Comptes Rendus, 176. p. 285, 1923, the author found for the advance of a planet's perihelion, the value $\delta\omega = \epsilon/3(-\alpha + 2\beta + 2\lambda)$, where $\epsilon = 6\pi\mu/v^2a(1 - e^2)$ and α, β, λ are numerical constants, and $2a$ and e are the osculating major axis and eccentricity at the given moment. From this, he finds that the advance of the perihelion of Mercury, which is not explained by the Newtonian law, is explained by several simple laws of force, as well as by the theory of relativity, and he gives four examples; it is sufficient if $-\alpha + 2\beta + 2\lambda = 3$. In the present paper he applies these results to the increases in length of the siderial revolution of the four inner planets, and he calculates the corresponding increases in the mean osculating longitudes both according to his four simple laws of force and to the theory of relativity. But in three of his simple laws he finds that the increase of the planetary revolution is inadmissible, being of the order of a second, and he raises the question whether the corresponding corrections (about 0·25; 0·011; 0·031; 0·21 seconds) given by the theory of relativity are admissible either. It seems that the study of the length of siderial revolution of a planet may furnish an argument either for or against the theory of relativity.

A. S. D. M.

1343. *Photographic Studies of Nebulæ. Third Paper.* **J. C. Duncan.** (Mt. Wilson Observat., Contrib., No. 256. Astrophys. J. 57. pp. 137–148, April, 1923.)—Further studies of the form and structure of nebulæ from photographs made with the 100-inch and 60-inch reflectors and the 10-inch Cooke refractor in the years 1920–1922. [See Abstracts 693 (1920) and 94 (1922).]

AUTHOR.

1344. *Radiative Equilibrium in Giant Stars.* **A. Véronnet.** (Bull. Astronomique, 2. 6. pp. 409–423, 1922.)—Giant stars have masses of the same order as those of normal or even dwarf development. Similarly their photospheres seem to be at similar temperatures. This is not compatible with the explanation that giant stars are normal stars swelled up by excessive internal temperatures according to ordinary kinetic laws. The explanation offered is that the photosphere is a layer of gas which is held in equilibrium between gravity and radiation pressure from a hot nucleus. The gravitational force varies as the inverse square, the radiation declines somewhat faster owing to absorption, and hence a position of equilibrium can always be found. The photosphere will so adjust its constitution as to absorb the radiation from within. The author discusses the relations between the masses, temperatures, and radii of the nucleus and photosphere upon various assumptions as to the mechanisms of equilibrium. Generally it appears that the rate of cooling is less for a giant with a distended photosphere than for a smaller star, becoming less again as the temperature becomes quite low. Thus the majority of stars will

V.2
192

fall into either the giant or dwarf stages, types K or A. This appears to be the case.

If radiation equilibrium is assumed, the presence of the photosphere has no effect on the rate of cooling; if adiabatic (convective) equilibrium is assumed, the cooling falls off as the ratio of the radii increases, being for a ratio of radii, 100 only 1/10,000 of the value for a similar star without the outer photosphere. The most simple of the relations given connects the radii, r and r_1, the initial and final temperatures T and T_0 and the absolute magnitude μ.

$$\log r/r_1 = 2 \log KT_0/T + \mu/5$$

For a giant of type M and initial temperature 3000° the ratio of the radii increases from 7·11 for a star whose magnitude is 0 and final temperature 8000°, to 180 for one whose magnitude is 3·5 and final temperature 18,000°. Rotation will spread the photospheres out into an equatorial band and such are seen in many nebulæ. In the case of the sun, the zodiacal light may be the remnant of the general nebulosity while the corona represents the giant photosphere. A. Wh.

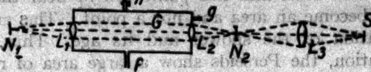
1345. *Disturbance of Meteoric Showers by the Earth.* **G. Shajn.** (Roy. Astron. Soc., M.N. 83. pp. 341–344, March, 1923.)—The method of variation of constants is applied to the theory of perturbations of meteors by the earth and four cases are worked out. By a criterion of Clausen, the disturbed orbits will have a common point of intersection with each other and the undisturbed orbit and this point will be near the earth. Hence the radiant will become an area and not a point. This area will increase with the elongation of the shower and its age. Thus, of showers of moderate elongation, the Perseids show a large area of radiation due to their great age. The Andromedids have a great elongation and have scattered considerably in the course of half a century, in fact, losing their character as a rich shower. Attention is called to the existence of ill-defined radiants near the anti-apex. Few of these are definitely recognised. A. Wh.

1346. *Temperature Ionisation in Stars of Type O.* **E. A. Milne.** (Observatory, 46. pp. 113–124, April, 1923.)—Recapitulation of a paper by Plaskett (Pub. Dominion Astrophys. Obs. i. 30. 1922) and extensive criticism of his theoretical deductions. Unsuitable for a detailed abstract. A. Wh.

1347. *Distribution of the Velocities of Stars of Spectral Type A.* **G. Strömberg.** (Mt. Wilson Observat., Contrib. No. 257. Astrophys. J. 57. pp. 77–85, March, 1923.)—The three velocity-components for 332 stars of spectral types B7 to F2 have been computed from their proper motions, radial velocities and spectroscopic parallaxes. The method used is that previously used for types F and M. The study of the distribution of the velocities reveals the existence of three well-defined groups. AUTHOR.

LIGHT.

1348. *Weakening of Visible Radiation by Artificial Homogeneous Fog.* **O. Werner.** (Ann. d. Physik, 70. 6. pp. 480–488, March 20, 1923.)—A study of the effect of magnitude and number of the drops of aqueous fog in air and in a vessel of definite length, the index of refraction and thickness of layer being therefore constant, on transmitted light. The weakening was determined by the spectrophotometric method of Kurlbaum and Schulze. [See Abstract 745 (1904).] The Nernst filament N_1 is placed at the focus of lens L_1, its light passes parallel through the fog receiver G and forms at N_2 a real image of N_1. Nearly in the same place, *i.e.* in the focus plane of lens L_2 but at a slightly different level from N_1, is the filament N_2, and both filaments are pictured in natural size by lens L_3 on the spectrometer slit. The difference of level must be such that the image of N_1 appears partly on the filament of lamp N_2, partly on the spectrometer slit. The two spectra are thus close together and suitably placed for photometry. The spectra being made equally bright, fog is generated in G, whereby the spectrum of N_1 is dimmed, and N_2 is then brought to the same brightness by regulating the current. To establish a relation between intensity of current and of radiation the Nernst filaments were compared with a dark body at three different temperatures. The radiant energy for a certain temperature and wavelength can be calculated by the Wien-Planck radiation formula. The magnitude and number of the drops in the fog were determined as follows: A large number of condensation nuclei was drawn into the receiver by gas flame suction. Air saturated with aqueous vapour was then admitted through the inlet *f*, generating an overpressure of $\Delta p = 5$ up to 40 cm. Hg. Reduction to atmospheric pressure produced a very fine, dense fog, the drops being large in number ($= 10^5$/c.cm.) but of very small radius ($0\cdot8$–$1\cdot0\,\mu$). This reduction precipitates a certain number of nuclei. If air be introduced into G through a cotton-wool filter a more attenuated fog is produced, the number of nuclei being smaller but the drop radius larger, the same volume of water being condensed to fog. The table drawn up by R. Mecke [Abstract 820 (1920)] enables us accurately to determine a radius of $0\cdot1\,\mu$. The drop number N is calculated from the condensed water volume *m* and the drop radius by the formulæ



$$N = \frac{3}{4}\frac{m}{r^3}\frac{1}{\pi}\,;\quad m = m_0\left[1 - \frac{T}{\rho}\left(\frac{\rho_0}{T_0} - ln\frac{T}{T_0}\right)\right];\quad \frac{T}{T_0} = \left(\frac{p-\pi}{p_0-\pi_0}\right)^{\frac{\kappa-1}{\kappa}}$$

T_0 and T are the absolute initial and final temperatures, ρ_0 and ρ the relative temperatures of evaporation, p_0 and p the initial and final pressures, π_0 and π the saturation pressures at initial or final temperature. Measurements were made in the red ($\lambda = 650\,\mu\mu$), yellow ($\lambda = 589\,\mu\mu$) and blue ($\lambda = 500\,\mu\mu$). The results are given in several curves. In order to express them in a formula it is best to start from the assumption that the fog particles are opaque circular discs whose radius is that of the drops. Let white light of intensity I_0 impinge parallel on a fog layer. If $N = n^3$ particles per c.cm. and therefore n particles per unit of length, and if the cross section q of the column of light traversing the fog have an intensity I, we may picture the path through the length l cm. of the receiver as being through nl layers, each of which contains n^2q discs. The author obtains the formula for diminution of intensity: $I = I_0e^{-3nlq/4r}$. Experimental results are more complicated. The drops act as refraction screens irregularly distributed in space, and the light which traverses them axially must be taken into account. The light passing through one drop may be so refracted by another as to be deflected into its initial direction. All these rays being coherent, interference is possible, and this might account for the dependence on colour. E. F.

1349. *Quantitative Absorption of Light by Simple Inorganic Substances. II. Chlorides of Arsenic, Antimony, and Bismuth.* **A. K. Macbeth** and **N. I. Maxwell.** (Chem. Soc., J. 123. pp. 370–375, Feb., 1923.)—With the halides of the alkali metals and hydrogen, the molecular extinction-coefficient in general increases with increase of atomic weight, the values lying between 0·05 and 0·5 [see Abstract 129 (1917)]. With arsenic, antimony, and bismuth trichlorides the values lie between 5 and 12,000, so that the use of solutions of widely different concentrations becomes necessary. Measurements made with azobenzene show that the molecular extinction-coefficient, as determined by the spectro-photometric method employed, is independent of the actual dilution of the solutions, and that the values obtained at different concentrations are in agreement with Beer's law. The value depends, therefore, only on the number of molecules of solute through which the light is passed, and no dilution effect will be observed if a compensation cell of solvent is interposed. In the arsenic-antimony-bismuth group the molecular extinction-coefficient increases with increase of the atomic weight of the element. The selective absorption by the bismuth is remarkable, but no explanation of this behaviour is yet advanced. T. H. P.

1350. *Critical Opalescence.* **A. Andant.** (Comptes Rendus, 176. pp. 430–433, Feb. 12, 1923.)—Application of photographic methods to spectrophotometry of critical opalescence and its variations with temperature and with wave-length. A. D.

1351. *Refractometry for Liquids.* **J. S. Anderson.** (Optical Soc., Trans. 24. pp. 49–50; Disc., 51–52, 1922–1923.)—A simple differential method for comparing samples of sea-water, glycerine, etc., with a standard sample. A. D.

1352. *Temperature Variations of Dispersion in Magnetic Double Refraction.* **G. Szivessy.** (Ann. d. Physik, 69. 3. pp. 231–240, Nov. 16, 1922.)—There are five different spectral λ's in nitrobenzol. The expression $C = \left\{\delta(n^2+2)^2/\vartheta n\right\} \cdot const.$ (C = Cotton-Mouton constant, ϑ = abs. temp., n = ind. refr., δ = density of liquid), derived from Langevin's molecular orientation theory, is not confirmed for any λ;

C increases more rapidly with diminishing ϑ. The Havelock law $C = h.(n^2 - 1)^2/n\lambda$, where h = Havelock's constant a function of ϑ, hitherto tested from 0° C. to 20° C., holds good for all temperatures. From Langevin's theory, $h \propto (\vartheta\delta)^{-1}$; but this is not confirmed by experiment; h increases more rapidly than this with falling ϑ. A. D.

1353. *On the Perfecting of the Microscope by the Use of X-Rays.* **G. Gouy.** (Comptes Rendus, 176. pp. 807–808, March 19, 1923.)—It is well known that diffraction fixes a limit to the resolving power of a microscope, this limit varying in a manner inversely with the wavelength λ of the light employed. The author now discusses the possibilities of achieving the ideal case where much shorter waves than ultra-violet (*i.e.* X-rays) are employed, weighing the relative possibilities of constructing a "microscope" to deal with such short waves either by the use of systems of "mirrors" or of "lenses." The remarks are intended merely to draw attention to the problem—not to indicate exact means of achieving the desired result. A. B. W.

1354. *The Measurement of Light.* **E. C. Crittenden.** (Washington Acad. Sci., J. 13. pp. 69–90, March 4, 1923.)—This paper contains the text of the Annual Address (1923) to the Phil. Soc., Washington, and deals with problems involved in the measurement of light, this choice of subject being made because of a certain degree of haziness prevailing in general ideas on the subject. Definitions and units are first considered, and are followed by a discussion of standards of candle-power with reference to the measurement of flux. The fundamental question of light evaluation is then dealt with at length. The limited significance of measurements is examined, the direct equality of brightness observations considered, and the use of flicker photometry described. The consistency of the latter makes it possible to establish the characteristics of an observer, and to predict what results he will obtain in comparison with an average observer. Visibility curves are discussed, but, while applications undoubtedly constitute a valuable supplement to more direct measurements, the situation will never be entirely satisfactory unless the values thus calculated can be checked. If the standard visibility curve be adjusted to make it agree with the usual equality-of-brightness photometer as now used for these measurements, flicker values can readily be brought into agreement by correcting them to a "normal" slightly different from the results which that instrument would give when used by the average observer. If such a solution for the fundamental problem of comparison of brightness can be obtained, and the black body is made to furnish a standard reference source, the system of assigning values to lights of every kind will probably be in as satisfactory a condition as the intrinsic difficulties of the subject will ever permit. H. H. Ho.

1355. *Molecular Scattering and Extinction of Light in Liquids.* **C. V. Raman** and **K. S. Rao.** (Phil. Mag. 45. pp. 625–640, March, 1923.)—The problem is dealt with theoretically and experimentally, the following being the general results: (1) The intensity of the light diffused in liquids is not given by the Rayleigh law of scattering. The "Theory of Fluctuations" of density developed by Einstein and Smoluchowski gives a quantitative explanation of the observed phenomena, if account is taken of the influence of molecular anistropy, which is very important in the case of liquids [Abstract 892 (1923)]. (2) The light scattered transversely by liquids is in general very imperfectly polarised ; this is more noticeable than in the case of the vapour of the same substance. This is explained by the general character of the distribution in the liquids of the molecules separately as regards *position* and *orientation.* (3) The intensity of scattering increases with the temperature in liquids and becomes very large as the critical point is approached. The polarisation of the scattered light tends at the same time to become more and more perfect. (4) Experiment shows that the state of polarisation of the scattered light is a function of the wave-length of the incident light, and this indicates that the observed optical anisotropy is probably connected with the resonance frequencies of the molecules in different directions and with the dispersive properties of the substance. (5) From the absolute determination of the light scattering in liquids the Avogadro constant can be calculated.

J. J. S.

1356. *Non-Achromatism of the Eye and Visual Acuity.* **A. Polack.** (Comptes Rendus, 176. pp. 859–861, March 19, 1923.)—The author shows that the theory of d'Alembert, in which it is supposed that the eye focuses on the plane of crossing of the red and violet rays, gives a much larger circle of confusion (from the point of view of actual visibility) than if the eye focuses for the focal plane of the light of maximum visibility. The rays in the end regions of the spectrum have a much lower visibility than those in the middle, so that a minimum confusion as regards vision is produced by focusing in the rays of the yellow-green. The author describes a physical experiment which demonstrates this effect.

J. W. T. W.

1357. *Comparison of the Fechner and Munsell Scales of Luminous Sensation Value.* **E. Q. Adams.** (Optical Soc. of America, J. and Rev. Sci. Inst. 6. pp. 932–939, Nov., 1922.)—The author examines the Fechner and the Munsell (or Stefanini) scales in the light of the newly-found relation of Adams and Cobb connecting sensation and brightness. With constant adaptation of the eye the functional relation between the sensation s, and brightness B, is $s = B/(B + k)$ where k is a constant dependent upon the state of adaptation, being equal to the brightness at which photometric precision is a maximum for the given state of adaptation. Only if the state of adaptation of the eye is maintained constant is it proper to speak of luminous sensation as a function of brightness ; the relation between s and B assumes an infinite number of forms according to the value of k. Many formulæ found empirically are special cases of Plateau's formula $s = k'B^{\epsilon}$ where k' is a constant and ϵ an exponent lying between 0 and 1, *e.g.* $\epsilon = \frac{1}{3}$ gives the Stefanini equation on which the Munsell scale is based, $\epsilon = 1$ gives the Merkell proportionality law and $\epsilon \rightarrow 0$ the Fechner law. All the equations are of such form that within the range of validity of Weber's law they may be made the same for the relation between s and B as for the relation between s and test-object "albedo" (the brightness relative to that of a perfectly diffusely reflecting surface similarly illuminated). A table is given showing the relation between sensation and test-object albedo according to the various scales and theories. From the corresponding curves it is seen that all the other curves lie within those for the Adams and Cobb formula representing the limiting cases of $k \rightarrow 0$, $k = \infty$, *i.e.* of constant adaptation to zero and infinite brightness. Hence, by appropriate constancy or variation in the state of adaptation during the measurements any of the relations could be obtained experimentally. With the eye adapted to the brightness corresponding to the geometric mean of the albedos corresponding to the Munsell scale numbers 1 and 9, the relation between sensation and brightness agrees with the Fechner scale; if adapted to the arithmetic mean of the same brightnesses the relation agrees well with the Stefanini equation. Also the Munsell scale agrees fully as well with the equation of Adams and Cobb (for $k = \frac{1}{2}$) as with the Stefanini equation. In view of the marked dependence of subjective value on the state of adaptation of the eye, greys should be rated according to their albedo, which is a physically determinate property. T. H.

1358. *Influence of Molybdic Acid and of Molybdates on the Rotatory Power of Malic Acid.* **E. Darmois.** (J. de Physique et le Radium, 4. pp. 49–70, Feb., 1923.)—Malic acid is feebly lævorotatory, but becomes more strongly lævorotatory under the influence of molybdates. On increasing the proportion of molybdate the lævorotation passes through a maximum, then diminishes, the sign is reversed, and the solution exhibits a very powerful maximum dextrorotation. A novel method of analysing the data showed that the maximum dextrorotation was due to a definite chemical compound, and by making up a solution to correspond with this composition a crystalline product was isolated where hitherto only syrups had been obtained. The crystalline ammonium salt has the composition $(MoO_4)_2C_4O_4H_6(NH_4)_2 + 2H_2O$, $[\alpha]_{5780} = 220°$, $\alpha_{4360}/\alpha_{5780} = 2{\cdot}26$, $\alpha_{5460}/\alpha_{5780} = 1{\cdot}165$. The sodium salt has the composition $(MoO_4)_2C_4O_4H_6Na_2 + 3H_2O$.

The maximum lævorotation is due to a salt containing 1 molecule of molybdic to 2 of malic acid, instead of conversely. Henderson has isolated the salts $MoO_2(C_4H_4O_5Na)_2 + 3H_2O$ and $MoO_2(C_4H_4O_5K)_2 + 2H_2O$. The ammonium salt has now been prepared and gave $[\alpha]_{5780} = -66°$. Indications have also been obtained of salts with twice this proportion of alkali, *e.g.* $MoO_3 : 2C_4H_6O_5 : 4NaOH$ instead of $2NaOH$. T. M. L.

1359. *Law of Magnetic Rotation.* **H. Collins.** (Chem. News, 126. pp. 197–200, March 29, 1923.)—The law is advanced that "The magnetic rotation of an electropositive element, when in combination, is the product of half its atomic weight [? its atomic number] and the reciprocal of its relative volume." T. M. L.

1360. *Projection of Polarised Light Phenomena.* **L. W. Taylor.** (Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 221–224, March, 1923.)—Describes a simple form of apparatus for demonstrating the phenomena in polarised light to a lecture audience. Both polariser and analyser consist of a pile of glass plates, the number of plates being adjusted to suit the strength of the light source. J. W. T. W.

1361. *Transparent Selective Radiators as Sources of Light.* **F. Skaupy.** (Zeits. f. Physik, 12. 3 and 4. pp. 177–183, 1922.)—In the Welsbach mantle the thoria is a typical transparent non-radiator, the ceria is a typical transparent selective radiator. The laws of such mixtures are simpler than those of selective radiators which approximate to black bodies. Transparent selective radiators do not necessarily present an increased efficiency with increasing temperature. The greatest economy in energy is secured by electric heating, or by the impact of kathode rays especially on crystals. A. D.

1362. *The Spectral Energy Sensitivity of Photographic Materials.* **L. A. Jones** and **A. L. Schoen.** (Eastman Kodak Co. Research Lab., Comm. No. 166. Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 213–217, March, 1923.)—Most of the published data on the sensitivity of photographic materials relate to visual evaluations of radiant energy, that is, in terms of light. The present paper deals with the results of energy measurements, using a tungsten ribbon in a gas-filled bulb as the radiation source, a Hilger quartz monochromatic illuminator for the dispersion, and a Hilger linear thermopile in conjunction with a Leeds and Northrup galvanometer. Tabulated results are given for the energy, inertia and quanta values for different wave-lengths ($\lambda = 400$ to $460\ \mu\mu$). The energy for a γ of unity, and wave-length of 400, was found to be 0·22 ergs per sq. cm.; the exposure time in seconds to give unit density was also unity. Reference is also made to the relation between the amount of energy incident, and the grain sizes; for these, tabulated values are given. A. W. J.

1363. *Action of Hydrogen Peroxide on Photographic Gelatino-Silver Halide Emulsions.* **S. E. Sheppard** and **E. P. Wightman.** (Eastman Kodak Co. Research Lab. Comm. No. 158. Frank. Inst., J. 195. pp. 337–347, March, 1923.)—It has been known for a long time that both the vapour and the solution of H_2O_2 have an action on the photographic plate somewhat similar to that of light. W. J. Russell, in 1899, was the first to give any quantitative data concerning this action. The work of Russell has since been substantiated, as well as elaborated, by others, who have compared more in detail the action of H_2O_2 on the photographic plate with that of light. A brief synopsis of this work is given. The object of the present investigation is to compare the action of H_2O_2 on the photographic emulsion with that of light. There are two aspects to this, which may be termed macroscopic and microscopic. In the first, photographic density D, which is proportional to mass of silver, determined as a function of conditions of exposure to peroxide can be measured, and it can be ascertained if laws similar to photographic light action obtain. It has been proposed to term the action of chemicals, such as peroxide, "photechic." In the second, using "one-grain layers," the relation between the number and size of grains made developable by peroxide as also the distribution of development nuclei in the grains must be determined, as has recently been done by Svedberg for the action of light. The present paper deals only with the macroscopic side. It is found that the sensitometric characteristics of photographic plates exposed to H_2O_2 and developed are strikingly similar, both for time of exposures, time of development, and intensity, *i.e.* concentration. Characteristic curves similar to H and D curves were obtained, including a period of "reversal." A tentative theory of the action of H_2O_2 is suggested. It is supposed that the decomposition of peroxide is chemi-luminescent, short wave-length radiation being afforded at the surface of the silver halide grain, and particularly at photosensitive nuclei. It is hoped that the reaction may be used to check the hypothesis that these nuclei consist of colloid silver. A. E. G.

1364. *Note on the Shrinkage of Photographic Films.* **H. L. Curtis.** (Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 275–276, March, 1923.)—The paper contains an account of the method of measuring film shrinkage and gives the results of these measurements. The method used was to make a contact exposure of a scale ruled in the metallic surface of a mirror. After exposure the films were developed, washed, and dried. The results of the measurements showed that the shrinkage was a variable quantity, the average value being about 0·65 per cent.; other values ranged from 0·55 to 1·07 per cent. dependent upon the locality of the film. The effect of varying the development and drying processes is mentioned, and it is stated that the effect of using alcohol for rapid drying is to increase the amount of, but reduce the variation of the shrinkage. A. W. J.

1365. *An Instrument for the Measurement of High Photographic Densities.* **L. A. Jones.** (Eastman Kodak Co. Research Lab., Comm. No. 160. Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 231–242, March, 1923.)—This paper describes the drawbacks of the Marten's polarisation photometer when used for measuring high photographic densities, by the addition of supplementary densities, and proceeds to a description of an instrument for measuring densities of high values, including those of process and X-ray materials. The instrument, which consists of a train of prisms and lenses, for the direct and comparison beams, employs an adjustable sector diaphragm for the density measurements. A Mazda tungsten lamp with a helical filament is used for the light source. A Lummer-Brodhun photometric cube is used for the beam comparisons. The paper contains diagrammatic and photographic illustrations of the instrument and includes tabulated results of X-ray measurements obtained. A. W. J.

1366. *A Special Sensitometer for the Study of the Photographic Reciprocity Law.* **L. A. Jones.** (Eastman Kodak Co. Research Lab., Comm. No. 161. Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 305–319, April, 1923.)—A brief account is given of existing methods and apparatus for varying the intensity, time period or distance, in the case of photographic sensitometers, and the disadvantages of each outlined. The essential requirements are enumerated, and an instrument described, in which the time and light source intensity can be varied. For the time variation a special sector disc is used, but only one revolution is made, so that errors due to the intermittency, in ordinary sector instruments, do not arise. The disc is driven by a synchonised, or controlled electric motor, an adjustable governor being fitted. An electrically operated shutter in front of the lamp house switches on and off the light at the correct moments, so that the wheel does not expose again after one revolution. Constructional details and illustrations of the timing and controlling devices are given, and an account is included of the means whereby both low and high intensities of light can be provided for. It is claimed that the illumination values and the timing periods of exposure can be determined to within ± 1 % with this sensitometer. A. W. J.

1367. *Spectro-Photoelectrical Sensitivity of Argentite* (Ag_2S). **W. W. Coblentz.** (Bureau of Standards, Sci. Papers, No. 446. pp. 265–280, 1922.)—Data as to the effect of temperature, of the intensity of the radiation-stimulus, and of mechanical working of the material, on the spectro-photoelectrical sensitivity of argentite. These data were found to be quite unlike those for acanthite, another form of Ag_2S. Hence crystal structure has a marked effect on spectro-photo electrical sensitiveness. A. D.

1368. *Spectro-Photoelectrical Sensitiveness and Atomic Weights.* **W. W. Coblentz** and **J. F. Eckford.** (Bureau of Standards, Sci. Paper, No. 456, pp. 489–498, 1922.)—The effect of increasing the atomic weight is to shift the maximum of the photoelectrical reaction towards the long wave-lengths. A. D.

1369. *A Fluorescing Substance.* **M. Kimura** and **G. Nakamura.** (Japanese Journ. Phys. 1. 5 and 6. pp. 41–48, 1922. In English.)—Study of a new substance in mandarin orange peel. A few mm. thickness of a benzene solution completely cuts off ultra-violet rays shorter than λ3800. A. D.

1370. *Triboluminescence.* **H. Longchambon.** (Comptes Rendus, 176. pp. 691–693, March 5, 1923.)—As in saccharose, so in tartaric acid, cadmium sulphate, uranium nitrate, and calcium fluoride, triboluminescence presents nitrogen bands and is therefore due to an effluvium in nitrogen or air. A. D.

1371. *Magnetic Rotary Dispersion in Gases.* **T. H. Havelock.** (Phil. Mag. 45. pp. 560–576, March, 1923.)—Comparison between the ordinary dispersion of certain gases and the dispersion of magnetic rotation in regions free from absorption. Formulæ derived from a simple static molecule with one type of vibrator are sufficient for both dispersions in the visible spectrum for gases like H and N. On the other hand, the case of oxygen, in which $V\lambda^2$ decreases with decreasing λ, indicates the necessity of including the magnetic properties of the molecule before a complete theory can be formed. Omitting paramagnetic effects, expressions for the rotary dispersion are obtained for an anisotropic static molecule, such as have been used for the ordinary dispersion of hydrogen. Two formulæ of this kind are compared with Sirks' observations in the ultra-violet; the modification improves the agreement, but not sufficiently. Similar conclusions are reached after a numerical study of the Bohr molecule for hydrogen, following Sommerfeld's analysis of the ordinary and magnetic dispersion. In all cases the adjustable constants for ordinary dispersion were found from gases at ordinary temperatures and pressures, those for magnetic dispersion from gases at high pressures: desirable to have parallel sets of observations on the same gas under similar conditions. A. D.

1372. *Spectroscopy.* **A. Sellerio.** (N. Cimento, 25. pp. 69–75, Jan.–Feb., 1923.)—Draw out a glass tube to a 1·2 mm. bore; dip its point in finely powdered sulphate of copper; put the tip in the electric arc; the tip melts into a bead; leave the bead in the arc; suddenly the copper lines flash out brilliantly and last for a considerable time. These lines stand among the lines proper to the glass, which are useful as standards of reference. Brilliant effects are obtained with Cu, Zn, Cr, Mn, Rb; less well marked with Fe, Ni, Bi, Ag, Al, Hg; none with Pb, Wo in aceto-tungstate of soda. A. D.

1373. *Einstein's Pin-Hole Radiation and Maxwell's Equations.* **C. W. Oseen.** (Ann. d. Physik, 69. 3. pp. 202–204, Nov. 16, 1922.)—Maxwell's equations have solutions, not exact, but approximating to the properties of Einstein's pin-hole radiation. In other words, they represent a monochromatic radiation from a point-source, the energy of which radiation, up to within a vanishing proportion, radiates only within a given extremely small solid angle. A. D.

1374. *The Infra-Red.* **M. Rusch.** (Ann. d. Physik, 70. 5. pp. 373–390, March 8, 1923.)—Determination of the average point of the calc-spar oscillation field to $6763 \cdot 2 \times 10^{-7}$ cm., and the rise of this with increasing temperature. The refractive quotient of air and argon at five points between 546 and 6763 $\mu\mu$ are determined by Michelson's interferometer; J. Koch's rise of the dispersion curve for air in the infra-red is due to a defective method. The formula $\nu_0 - 1 = C/(n_0^2 - n^2)$ holds good only within a very limited region. A. D.

1375. *Electrons of Krypton.* **G. Déjardin.** (Comptes Rendus, 176. pp. 894–897, March 26, 1923.)—Extension of previous work on argon, helium, and mercury [Abstracts 499 and 1197 (1923)]. Like argon, krypton has two spectra, the one due to loss of one electron, the other due to the loss of two. A. D.

1376. *Ultra-Violet Absorption Spectra of the Cresols.* **F. W. Klingstedt.** (Comptes Rendus, 176. pp. 674–676, March 5, 1923.)—In continuance of work on phenol and aniline [see Abstract 1597 (1922)] and [Abstract 1136 (1923)]. The same difference is observed for cresol as for the other substances, in the absorption spectra when dissolved in alcohol and in hexane. The method adopted was to use the Al spark under water, and observe the darkening produced in the microphotometer. The absorption spectra of *o*- and *m*-cresol are practically identical. Two bands occur at λ2780 and λ2716 for *o*-cresol, and at λ2796 and λ2720 for *m*-cresol, corresponding to the two bands of phenol. These bands are approximately 107 Å.U. displaced towards the red, compared with toluene; the intensity of absorption is nine times greater. *p*-Cresol has seven narrow bands between λλ2858 and 2644; compared with the *o*- and *m*-spectra it is displaced 70 Å.U. towards the red. Many bands seem typical of the *p*-compounds, and can be taken as a criterion. These seven bands of *p*-cresol can be divided into three groups; in each group the differences in wave-number are constant, and the absorption intensity decreases. The mean value of $\Delta\frac{1}{\lambda}$ is 1217 Å.U. A. C. M.

1377. *On the Combination Principle and a New Class of Bands.* **A. Kratzer.** (Zeits. f. Physik, 13. 1 and 2. pp. 82–84, 1923.)—Recently Hulthén [see Abstract 901 (1923)] has indicated some extremely important combination relations in a series of band spectra. These results are now somewhat extended by the present author and in part corrected. It is also shown provisionally that in the (C + H) bands, the doublet which Heurlinger derived may be simply expressed by the introduction of a term for which a theoretical treatment based on molecular precession movement has already been given (Ann. d. Phys. 1923). Hulthén has distinguished among the Hg, Mn, and Cd bands two groups which he opines to follow different combination laws, but these are now shown to belong to one group only. Different enumeration is, therefore, proposed for certain of these lines, and tables of data so corrected are included. H. H. Ho.

1378. *Ultra-Violet Absorption Spectrum of Toluene Vapour.* **V. Henri** and **E. Walter.** (Comptes Rendus, 176. pp. 746–748, March 12, 1923.)—The absorption spectrum of the vapour of toluene is composed of a large number of narrow bands of which the authors have measured more than 200. They are distributed between $\lambda = 2731$ and 2325, have sharp edges on the ultra-violet side and shade off towards the red. The band spectrum of toluene is much more complicated than that of benzene. The authors give a formula which expresses the law of distribution of all the bands of toluene which have been observed. J. J. S.

1379. *Ultra-Violet Absorption Spectra of Benzoic Acid and of the Three Oxybenzoic Acids.* **A. Castille** and **F. W. Klingstedt.** (Comptes Rendus, 176. pp. 749–750, March 12, 1923.)—The authors have measured by Victor Henri's method the ultra-violet coefficients of absorption of benzoic acid dissolved in hexane, and of the three oxybenzoic acids in solution in a mixture of hexane and ether. (1) The introduction of a COOH group into the benzene nucleus causes a displacement of the spectrum towards the red of about 230 Å., the coefficient of absorption is increased about four times, and a widening of the benzene bands takes place. The absorption spectrum of benzoic acid shows in a first region three somewhat narrow bands A : $\lambda = 2831$ with coefficient of absorption $\epsilon = 860$; B — 2760, $\epsilon = 860$, and C — 2735, $\epsilon = 700$; and much further towards the ultra-violet a strong wide band for $\lambda = 2310$, $\epsilon = 5000$. There exists also probably a very strong band of $\epsilon > 20{,}000$ in the extreme ultra-violet for $\lambda < 1935$. (2) The introduction of an OH into the benzoic acid nucleus in the *ortho* or *meta* position causes a strong increase of the absorption, an intense shifting of the spectrum towards the red, and a widening of the narrow bands. (3) The two *ortho* and *meta* derivatives present almost the same spectrum of three bands. (4) The spectrum of the *para* derivative is entirely different. It shows five narrow bands between 2828 and 2671, a wide and very intense band for $\lambda = 2519$, $\epsilon = 15{,}730$, a band about $\lambda = 2100$, and a wide band in the extreme ultra-violet beyond 1935. These characteristics are exhibited by an absorption curve of benzoic acid and its three derivatives which is given in the paper. The results are similar to those previously obtained for the *o*, *m*, and *p* derivatives of benzene. J. J. S.

1380. *Ultra-Violet Absorption Spectra of Veratrol and of Vanilline.* **P. Steiner.** (Comptes Rendus, 176. pp. 744–746, March 12, 1923.)—Investigation has been made of the absorption of veratrol, dimethylated derivative of pyrocatechine, and of vanilline, methylated ether of dioxybenzaldehyde. The curve of absorption of *veratrol* is very similar to that of pyrocatechine. It shows a group of three narrow bands in the middle ultra-violet about 2800 Å., the third band distinctly less pronounced than the others ; and a fourth band more intense and wide in the extreme ultra-violet. The differences of position of the three first bands in pyrocatechine and veratrol are very small and their coefficients of absorption are of the same order of magnitude. The fourth band is displaced about 100 Å. towards the red compared with that of pyrocatechine, and its intensity is about twice as great. The fact which appears from this comparison is the small influence exerted on the absorption by the introduction of two methyl groups into the molecule of pyrocatechine. In the spectrum of *vanilline* is found the group of the three first narrow and slight bands of pyrocatechine and veratrol but displaced towards the red about 200 Å., whilst the intensity of absorption is tripled. The wide band in the extreme ultra-violet is also present, displaced towards the small wave-lengths and with a doubled coefficient of absorption. A new wide band in the middle ultra-violet is also found which must be due to the action of the aldehyde group. With reference to this new band, benzoic aldehyde possesses in this spectral region two bands, one towards the great and the other towards the small wave-lengths. It is not yet possible to determine with certainty to which of the two that of vanilline corresponds. J. J. S.

1381. *Infra-Red Absorption of Hydrogen Chloride in the Region $3\cdot5\mu$, and at 200° K.* **B. J. Spence** and **C. Holley.** (Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 169–173, Feb., 1923.)—Measurements were made at 291° K. and 200° K., with a grating spectrometer and a specially designed radiometer of the Nicols type. The brass absorption cell was closed with mica at the top, and had a silver mirror at the bottom, so that the radiation from a Nernst glower passed twice through the gas; the cell was cooled with liquid air. At both temperatures there are two groups of fine absorption bands; the "envelope" curves passing through these maxima show two maxima at each temperature, one on either side of the central wave-length, where the absorption is a minimum, which divides the two striated bands. The position of these two maxima depends on the temperature; and for the temperature 291° K. there is fairly good agreement as regards this position between the experimental results and Kemble's theory [Abstract 239 (1917)]. For 200° K. there is divergence, which may indicate that the theory requires modification at low temperatures (the temperature of liquefaction of HCl is 190° K.). It is, however, difficult to fix the position of the envelope curves; and the apparent deviation from the theory at low temperatures may be due to this. Reiche's theory [Abstract 1072 (1920)] indicates that at 291° K. the bands of maximum absorption should be the third bands on either side of the centre, while at 200° K. they should be the second bands; this agrees with experiment. No shift in the position of the fine bands with temperature was observed, which is in agreement with theory. H. N. A.

1382. *Tesla Luminescence Spectra. Part I.* **W. H. McVicker, J. K. Marsh,** and **A. W. Stewart.** (Chem. Soc., J. 123. pp. 642–654, March, 1923.)—The luminescence emitted by vapours of organic compounds when subjected to a Tesla discharge was examined with a quartz spectrograph. The vapour was made to pass through a water-jacketed cell, having a quartz window, a central electrode, and metal-foil for the other electrode. The cell was viewed end-on. A Hilger type C spectrograph was employed. Aniline gives a short, continuous spectrum, and benzene a portion of the carbon spectrum, both liquids being examined at the boiling-point and atmospheric pressure. On reducing the pressure, benzene gives a spectrum consisting of several groups having the same internal structure, $\nu = 98 \cdot 712n - 98 \cdot 712m/6$, where n equals 33, 34, 35 . . . and m equals 0, 1, 2, 3, 4 . . . . On comparing with the fluorescence spectrum of benzene in alcoholic solution, it is found that a shift of 19 units towards the ultra-violet of the fluorescence spectrum makes it identical with the brighter parts of the Tesla spectrum. The bands found for benzene agree within experimental error with Hartley's bands in the absorption of benzene vapour. Thus the Tesla luminescence spectrum is the emission spectrum corresponding to the Hartley absorption spectrum; *i.e.* the Fraunhofer effect is demonstrated for a complex organic compound. The empirical formula employed is found to give wavelengths in the infra-red region which are in agreement with previous experimental results.

Part II. **W. H. McVicker and J. K. Marsh.** (*Ibid.*, pp. 817–820, April, 1923.)—This paper is a continuation of that referred to in the preceding abstract, and deals with the changes in the Tesla spectrum of benzene produced by variations of pressure and temperature. Two more series of bands are observed at a pressure of 1·6 mm.; these are of a different type from those previously observed. These bands are much weaker. The sharper of the bands in these two groups seem to coincide with Henri's bands in the absorption spectrum of benzene vapour [Abstract 1596 (1922)]. A range of pressure from 1·6 mm. to 20 cm. was investigated; increasing the pressure curtails the spectrum on the short wave-length side. Spectra taken at 15° and at 150° at constant pressure and also at constant volume were compared; bands were less clear at the higher temperature, and also curtailed at the violet end. A. C. M.

1383. *Relationship of the Sodium Arc, First Magnesium Spark, and Second Aluminium Spark Spectra.* **E. Fues.** (Zeits. f. Physik, 13. 4. pp. 211–220, 1923.)—These three spectra must come from atoms having similar structure; the nuclear charge is increasingly greater, and the excess of positive over negative charge increases progressively. Consequently the atom will be of smaller dimensions in the case of Al^{++} than for Na. This contraction is calculated, and it is shown that if the values of one of the X-ray terms of the elements is known, *e.g.* the L_1 term for all three metals, then the spectrum of Mg^+ and Al^{++} can be calculated from that of Na. As an example, the value of 1·5S for Al^{++} is calculated and shown to agree within less than 3 % with that calculated from Paschen's measurements. A. C. M.

1384. *Spark Spectra of Higher Order.* **L. and E. Bloch.** (Comptes Rendus, 176. pp. 833–835, March 19, 1923.)—Lockyer's long and short lines as usually produced belong to the arc and the spark spectrum respectively. It is possible to advance the process one stage, and so have long lines corresponding to singly charged atoms and short lines to atoms doubly charged, and so on. The authors have investigated mercury between 5000 and 2200 Å.U. A drop of mercury was introduced into a silica tube, which was exhausted and then sealed. The tube was then subjected to the electrodeless discharge. The tube was placed in an electric furnace, and the excitation produced by a strongly condensed oscillatory discharge from a transformer round a few turns of wire wound on the tube. The short, spark lines are found to be developed most strongly where the field is strongest, and at the expense of the arc lines, As the field is increased, the spark lines move inwards towards the region of less intense field, and other lines appear at the periphery, and in turn move in. These last lines ("E_2") are attributed to the doubly ionised atoms; the former to the singly ionised atoms ("E_1"). Tables are given of representative lines from the two types. A. C. M.

1385. *High-Frequency Spectrum of Celtium.* **A. Dauvillier.** (Comptes Rendus, 176. pp. 676–679, March 5, 1923.)—In reply to a letter of Coster and v. Hevesy, doubting the correctness of attributing 1319·4, 1561·8 X to celtium [Abstract 2086 (1922)].

The author admits a discordance of 3 X units (10^{-11} cm.) between his values and the probable values of β_2 and α_1 for celtium, but claims that it is within the errors of experiment. The possibility of the lines being due to higher order of another element is discussed and dismissed. Improvements in the experimental arrangements have led to sharper lines, giving values $\beta_2 = 1323$ and $\alpha_1 = 1564$, in better agreement with the probable values. A line 1373 X having the same intensity as β_5 of ytterbium is now obtained (presumably β_1 of celtium). The author reaffirms the presence of a trace of celtium in the preparation discussed in their first paper, and again claims the prior discovery of the element 72. A. C. M.

1386. *Intensity Ratios in the Sharp Series of Sodium.* **H. Bartels.** (Zeits. f. Physik, 14. 2. pp. 169–172, 1923.)—The intensity ratio for the first lines of the principal series has been found to be two, for the case of absorption [see Abstract 229 (1914)]. It has now been found by the author that the ratio of the intensities of the pairs of lines forming the sharp series is also two, in this case measured for emission. A carbon arc was used, the positive pole being hollowed out and NaCl introduced. Photographs were taken through a train of three prisms, and the blackening estimated with a Hartmann microphotometer. Five doublets were observed, and the values vary between 1·92 and 2·12. A. C. M.

1387. *Effect of Electronic Impact on the Atomic and Molecular Spectrum of Hydrogen.* **V. v. Keussler.** (Zeits. f. Physik, 14. 1. pp. 19–31, 1923.)—Measurements of the ionisation potential of the hydrogen molecule, together with theoretical considerations, make it probable that at the lowest degree of ionisation of hydrogen, a decomposition of the molecule into a normal H-atom, a H^+-ion, and an electron takes place. If an impacted molecule possesses equal or greater energy than the sum of the dissociation and ionisation work, then through the impact the molecule disintegrates into the above components. Experimental work of Franck [see Abstracts 23 and 673 (1923)] and Pauli on the ionisation stages is quoted. The present investigation attacks the problem by means of spectrum measurements. Experimental details are given. It is found that the dissociation of hydrogen by electronic impact takes place in two stages, of which the first is the activation of the molecule and the second the disturbance occasioned prior to the radiation of energy. Disintegration can take place in both a normal and an activated atom, when the energy which a molecule contains before impact is sufficiently great. It is shown that the distribution of the intensity dependent on the velocity of the electrons is very different as regards the single lines of the many-lined spectrum of hydrogen. H. H. Ho.

1388. *Radiation and Ionisation Potentials of the Rare Gases, and the Series of Argon.* **W. M. Hicks.** (Phil. Mag. 45. pp. 480–496, March, 1923.)—An extension of views put forward in the "Analysis of Spectra." The "true" ionisation and radiation potentials are defined as the energy required when the molecule is already dissociated, or the atom brought to the "prepared" state. For hydrogen, two sets of values are found, the lower values being the "true" values; this means that the atoms must form a considerable part of the gas, and this is confirmed by Wood's observation that H takes $\frac{1}{3}$ second to form H_2. In the *rare gases*, the potentials found are too high. This is to be attributed to the work necessary to "prepare" the atom. The discussion is simplified by the notation employed. • ● – ● • represents a normal atom; a small dot is a "level," a large dot an electron, and the bar the nucleus. A "prepared" atom is then either • ● – • ● or ● • – • ●, while an ionised atom will be • ● – • •.

In *helium*, the calculated value of 4·75 volts for the true ionisation potential, and the prediction that the prepared atom has a long life, are confirmed by Kannenstine [see Abstract 1896 (1922)]. In *neon*, it is concluded that more than one stage of preparation for gases beyond helium exist. The second set of potentials are ascribed to • • ● – • ● •, while the third potential found—20 volts—may possibly be due to • ● • – • ● •.

Argon.—A correction is made to the conclusions in the "Analysis." Basing the argument on the spectra observed in potential measurements [see Abstract 545 (1923)], the true ionisation potential of argon is deduced to be 4·66 volts, and also the arc should die away in more than two steps. Some series are then traced in the spectral lines of argon. A. C. M.

1389. *Zeeman-Effect of the Swan Band* λ3872. **R. Fortrat.** (Ann. de Physique, 19. pp. 81–92, Jan.–Feb., 1923.)—The effect of the magnetic field on the different lines in the band is not the same, and the lines can be grouped accordingly. The single lines are affected in the usual manner of band lines, *i.e.* a doublet is formed whose separation does not follow a simple law, but yet has a value approximately equal to the normal separation, $\partial\nu = 0 \cdot 936 \,.\, 10^{-4} \,.\, H$.

The pairs of lines forming groups A and B have real physical similarity; as the intensity of the field is increased the doublet runs together to form a single line. Previous work on λ3141·8 in the second nitrogen positive group suggests that the cause lies in the fine structure of the line. It is suggested that this phenomenon may have an explanation similar to that of the Paschen-Back effect. Some of the lines appear to obey a law analogous to Runge's law for series lines. The polarisation of the different components is also discussed. A. C. M.

1390. *Intensity of Complex Lines.* **H. Dorgelo.** (Zeits. f. Physik, 13. 3. pp. 206–210, 1923.)—A method of comparing the intensities of doublets, etc., applied to the doublet series of the alkalies. Light from an arc fed with salts of the metals investigated passed through a lens system, and was made to throw several images on the slit, of differing intensity due to the obliquity of the differing paths. The principle employed was that exposure to light sources of equal intensity should produce the same blackening for equal exposures, provided that the wave-lengths of the light-sources are equal or very nearly so. Different screens were used, and the spectrograms produced were measured with a microphotometer. In this way it was shown that in the sharp series of sodium and potassium the intensity-ratio of the components of the doublets is approximately 2, while for cæsium it is nearly 7. A. C. M.

1391. *Structure of H_α and H_β.* **A. E. M. Geddes.** (Roy. Soc. Edinburgh, Proc. 43. 1. pp. 37–42, 1922–1923.)—The doublet separation of the Balmer lines should be constant and have the value 0·365 cm.$^{-1}$, according to Sommerfeld. Paschen claims that the doublet separation should increase from H_α to H_δ, and then remain constant. Some experimenters have found a decrease, while Merton [see Abstract 1282 (1920)] has observed an increase. The author has measured the doublet separation for H_α and H_β, observing at different temperatures the light emitted from the capillary of a quartz discharge tube, using an echelon grating. A slight decrease is observed, agreeing better with McLennan's observations [see Abstract 889 (1922)]. H_β is seen as a triplet; it is suggested that the third member is due to the nitrogen line λ4861·4. A. C. M.

1392. *Theory of Dispersion in a System of Asymmetrical Dipoles.* **W. Gordon** and **H. Kallmann.** (Ann. d. Physik, 70. 2. pp. 121–128, Jan. 31, 1923.)—Work on the infra-red bands by Hettner and Heurlinger [Abstracts 1071 and 1073 (1920)]; and on the rise of the specific heat of solids over the Dulong Petit value, have led to the assumption that oscillators exist in gases and solids with an equation of motion of the form $\ddot{\xi} + n_0^2\xi + \beta\xi^2 = 0$, the influence of $\beta\xi^2$ being small. Here n_0 is the fundamental frequency (number of oscillations in 2π seconds, and the "overtones" $2n_0$, $3n_0$, etc., also occur; the absorption lines corresponding to these overtones were observed by Hettner, and their frequency was found to agree with the quantum theory. C. Schaefer, on the other hand, finds that classical theory shows no abnormality in the curves of absorption and dispersion for the overtones, which is contrary to the result of the quantum theory and to experiment. The authors work out an equation for the refractive index for a system of dipoles with linear oscillations, by studying the action on it of a plane wave, polarised linearly in the z axis; only one charge of the dipole (e, μ) is movable in the direction of the z axis. The equation shows the expected abnormality for $n = 2n_0$. Further consideration of the theory leads to the discovery of an abnormality for $n = n_0/2$; it is possible that an absorption line may be found at this point. H. N. A.

1393. *Absorption Limits of K-Radiation for Certain Elements.* **J. Cabrera.** (Comptes Rendus, 176. pp. 740–741, March 12, 1923.)—Results are given of a series of measurements of the K critical absorption frequencies for the rare-earths La to Ta (57 to 73 in atomic number). The original paper should be consulted. A. B. W.

1394. *Internal Quantum Numbers and Complex Spectra.* **A. Sommerfeld.** (Ann. d. Physik, 70. 1. pp. 32–62, Jan. 18, 1923.)—The author deals with the modifications in his theory [see Abstract 433 (1921)] necessitated by Catalán's work on the spectra of Mn and Cr [see Abstract 1143 (1923)]. The internal quantum number (j) refers to the impulse moment of the atom, and governs the number of components in a group, *i.e.* decides whether a series be doublets, triplets, etc. Catalán has shown that the principal and sharp series of Mn consist of simple triplets, as is expected; the diffuse series has, however, nine components. The *p*-terms are threefold, the *d*-terms fivefold. This involves giving the internal quantum numbers 3, 2, 1, 0, $\bar{1}$, instead of 3, 2, 1. The *b*-term is 7-fold, involving groups of 15 lines. Similarly the new series traced in Cr involve alterations in the theory, which had been based mainly on the alkaline earths. Taking Mn and Cr into consideration, a new law is proposed, that the number of levels for the terms *s, p, d, b* . . . is 1, 3, 5, 7 . . . The law of permanence of multiplicities, which before applied to all the levels, is now restricted to the number of levels beginning from $j = 0$. In the case of Mn, the forbidden transfer 0–0 takes place, while Cr follows the rule. The occurrence of negative values of j is explained by considering it as the algebraic sum of two numbers j_0 and j_1, which refer to the normal and the excited atom respectively. The calculation of paramagnetic moments from the value of j_0 is considered, and the number of Bohr magnetons for different atoms is compared with the number calculated on the assumption that the number j_0 is the number of magnetons. This assumption is thought to be unjustified. A. C. M.

1395. *Theory of Band Spectra.* **H. A. Kramers and W. Pauli, Jr.** (Zeits. f. Physik, 13. 6. pp. 351–367, 1923.)—This paper applies the results obtained by Kramers [Abstract 1312 (1923)] to molecules containing two atoms. A. Kratzer has considered molecular models with the electron impulse in any direction, but has not gone into the mechanical details. In a molecule with two atoms, when the electron impulse is rigidly connected, $2E = (P - S_1)^2/A + (Q - S_2)^2/B + (R - S_3)^2/C$; the total impulse, $I = mh/2\pi$, lies in the same plane as the direction of the electron impulse and the line joining the nuclei; there is a precession of the whole molecule about the impulse axis. The component of the total impulse perpendicular to the line joining the nuclei has the same sign as the corresponding component of the electron impulse. The infra-red bands are due to radiations of the molecules, which depend on the vibrations of the nuclei and the rotation of the molecule, and not on the configuration of the electrons. They can be investigated most completely in compounds of hydrogen with the halogens, and consist, in accordance with the theory, of two symmetrical series of approximately equidistant lines. The line in the middle of the band is, however, missing in each case. Kratzer's explanation of this fact is not very satisfactory; but the authors show that if the total electron impulse moment is $1 \cdot h/2\pi$, and if the angle between this moment and the line joining the nuclei is about 30°, this result follows. On other grounds the moment can be fixed as about $\frac{1}{2}h/2\pi$; presumably if this value is adopted the above angle will be different. The theory is employed in the consideration of the Stark and Zeeman phenomena; and considering new experiments by H. Falkenhagen, and by O. E. Frivold and O. Hassel, which show that the dipole length, calculated by the classical formula from the relation of the dielectric constant to the temperature, is considerably smaller than the nuclear distance, the authors conclude that in HCl, etc., the electron orbits of the octet layer of the Cl ion are considerably deformed by the presence of the H nucleus, the electron impulse moment being essentially different from that in the free halogen ion. The theory is applied to bands in the visible spectrum (Runge's oxygen bands). Here the electron configuration changes, the moment of inertia and the electron impulse moment being different in the initial and final state of the molecule; formulæ are obtained which explain the coarser structure. The paper concludes with a consideration of the effect of a loose coupling of the photo electron, and shows that certain peculiarities in the Zeeman phenomenon can be explained in this way. H. N. A.

1396. *A Determination of the Coefficient of Reflection of X-Rays for Calcite and Rock-Salt.* **B. Davis** and **H. M. Terrill.** (Phil. Mag. 45. pp. 463–470, March, 1923.)—If an X-ray beam after reflection from a crystal surface falls upon a second surface maximum reflection is obtained when the crystal planes are parallel. Some reflection is, however, observed when the second crystal is rocked through a small angle on each side of the position of parallelism, and indicates not only reflection of the rays of wave-length λ corresponding to $\lambda = 2d \sin \theta$, but some energy of neighbouring wave-lengths is also reflected. The amount of associated reflection, as indicated by the width of the rocking curves, depends upon the nature of the crystal, perfection of its crystalline surface, and condition of its surface, and introduces difficulties in specifying the reflectivity of a crystal.

W. L. Bragg [Abstract 1773 (1921)] and A. H. Compton [Abstract 308 (1917)] have both defined a quantity called the coefficient of reflection, and have determined values for different crystals, the former giving the coefficient in terms of radians and the latter in terms of degrees.

Bragg, in defining his coefficient, makes allowance for the imperfection of the crystal and gives an integrated or average result depending on the nature of the crystal, but not on its state of perfection. The authors propose to show that the value is not independent of the crystal surface, but depends upon the perfection of the crystal surface. The method used depended upon reflection at two crystal surfaces and measurement of the radiation from the second crystal by means of an ionisation chamber. Maximum reflection was obtained when the crystal planes were parallel, and curves of intensity, called rocking curves, were obtained when the second crystal was turned on each side of the parallel position. The second crystal could be moved aside to allow the beam from the first to be directly measured, and the ratio of the intensities was expressed as a percentage and taken as a measure of the reflecting power of the second crystal. The authors show the coefficient as defined by Bragg can be determined by planimetric measurement of the rocking curve.

Data are then given for experiments with three pairs of calcite crystals, one pair having internal flaws, one pair being polished, and the remaining pair being unpolished.

The three pairs showed marked differences in reflection and width of rocking curves, and the act of polishing doubled the coefficient of reflection. Similar investigations with rock-salt by Davis and Stempel showed that polishing did not have a marked effect on the reflectivity, but in general a direct comparison of the reflection of rock-salt and calcite cannot be made, since the rocking curve of rock-salt is low and wide, giving a high coefficient, and that for calcite high and narrow. The authors conclude that there is no single quantity which can be used as a measure of reflection, and to specify completely the reflecting power of a substance two constants are required; namely, the width of the rocking curve and ratio of reflected and incident intensities. B. J. L.

1397. *Diffraction of X-Rays by "Smectic" Substances.* **M. de Broglie** and **E. Friedel.** (Comptes Rendus, 176. pp. 738–740, March 12, 1923.) —The work of G. Friedel [see Abstract 1987 (1922)] has shown that there exist for matter, between the amorphous and the crystalline states, two possible intermediate states: the state "rématique," in which the molecules are distributed at random, but all have a common direction; the state "smectique," in which the molecules, having a common direction, are in addition arranged in equidistant parallel layers. "Cholesteric" substances, which appear to form a third group, are only "rématique" substances subjected to torsion. [Note.—The expressions rématique, sméctique, and cholesterique are proposed by Friedel to describe anisotropic liquids.] If the above ideas are correct, then cholesteric and rematic substances will not diffract X-rays, whereas smectic substances should reflect X-rays in a manner similar to that by a set of parallel atomic planes in a crystal. The investigation now described seeks to verify these deductions. A mixture of oleate of potassium, glycerine, and water was found by Perrin and Wells (Ann. de Physique, p. 69) to possess smectic properties, the distance apart of the molecular layers being from 42 to 44 Å.U. The authors now find by using K_α radiation (1·541 and 1·537 Å.) of copper, a value of 43·5 Å. in good agreement with the above result of Perrin and Wells. Analogous results were obtained with oleate of ammonium. A. B. W.

1398. *X-Ray Spectra, and the Periodic System of the Elements.* **N. Bohr** and **D. Coster.** (Zeits. f. Physik, 12. 6. pp. 342–374, 1923.)—The paper is a continuation of previous work by the authors [Bohr, Abstract 1941 (1922); Coster, Abstract 12 (1923)]; and compares the experimental data more closely with the theory, particularly in connection with the relation between the X-ray spectra and the explanation of the periodic system. New symbols are assigned to the electron layers in the atoms; the innermost layer being 1(1,1)K, and then follow $2(1,1)L_I$, $2(2,1)L_{II}$, $2(2,2)L_{II}$, and so on outward; these symbols replace $K1_1$, L_3, L_2, L_1, etc. The Roman subscript numbers indicate the subsidiary levels of the same level group, the symbols of the form $n(k_1, k_2)$, where n, k_1, and k_2 are whole numbers, define the subsidiary levels more closely, n being in each case the principal quantum number, while the k's are subsidiary quantum numbers. One of the figures of the paper shows the relation between the different lines of the X-ray spectrum and the above system of levels, the level from which the electron comes, and that to which it falls, being in each case clearly indicated. Coster has shown that ν can be represented as the difference between two spectral terms T′ and T″; these spectral terms, multiplied by h, can be regarded as the energy levels of an atom which is brought out of its normal condition by the removal of an electron from an inner group. Tables are given showing the values of T/R for a large number of elements, from U to Mg, for the different levels, and also the values of $\sqrt{T/R}$. R is Rydberg's constant. Curves are then drawn with atomic numbers as abscissæ and $\sqrt{T/R}$ as ordinates, which show that, although for the K lines the relation is practically a linear one, with no trace of the chemical periodic system, this is not the case for the other layers, which show more or less sharp irregularities, related to the position of the elements concerned in the periodic system. In the case of the rare earths, from cerium (N = 58) to lutetium (N = 72), where the theory of electron distribution shows the O and P levels unaltered throughout, while extra electrons are added to the N level, so that it gradually increases from 6,6,6 to 8,8,8,8 electrons, the curves for the N levels show a greatly diminished upward slope, while those for the O levels are nearly horizontal; the explanation proposed is that the outer loops of the electron orbits of these levels lie outside the region of the four quantum electron orbits (N orbits), and that they are screened from the action of the nucleus by the electrons in the inner layers, the effective charge inside them remaining constant throughout the group. For other details relating to the spectra of the inert gases, to doublets which depend on screening, and those affected by relativity, the original paper should be consulted. H. N. A.

1399. *Increased Dispersion in the Photoelectric Spectra of X-Rays.* **R. Ledrus.** (Comptes Rendus, 176. pp. 383–385, Feb. 5, 1923.)—De Broglie [Abstracts 1075, 1076, 1078 (1921)] has shown that when X-radiation of frequency ν_0 strikes an atom, the speed v of an electron emitted from a centre of energy W is given by the quantum relation $\frac{1}{2}mv^2 = h(\nu_0 - \nu)$ where m is the mass of the electron, h Planck's constant, and ν the frequency which corresponds to W by the relation $W = h\nu$. By means of a suitable magnetic field the electrons can be deviated in circular orbits and a velocity spectrum obtained on a photographic plate. The author has developed a method of increasing the dispersion in such a spectrogram. If e and ρ denote the electronic charge and the radius of its trajectory, then

$$H\rho = \sqrt{\frac{2hm(\nu_0 - \nu)}{e^2}}$$

whence $$-\frac{\partial\rho}{\partial\nu} = \frac{\rho}{2(\nu_0 - \nu)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

From (1) it is observed that the dispersion is increased by (*a*) excitation of the electronic emission by means of an X-radiation of which the frequency ν_0 is only slightly greater than the frequency ν corresponding to the "centres" under consideration; (*b*) adjusting the magnetic field to place the region studied towards that extremity of the plate which corresponds to large valves of ρ.

These observations are verified experimentally. A. B. W

1400. *X-Ray Absorption Coefficients of Carbon, Hydrogen, and Oxygen.* **A. R. Olson, E. Dershem** and **H. H. Storch.** (Phys. Rev. 21. pp. 30–37, Jan., 1923.)—Aurén [Abstract 439 (1919)], using non-homogeneous X-rays, found a large discrepancy between the absorption coefficients of graphite and carbon in organic combination. If this difference were real, aliphatic and aromatic carbon should differ from each other because of the difference of bonding. The authors have investigated this point with radiation of wave-length less than 1·0 Å. and have found that the absorption coefficients of aliphatic aromatic and graphite carbon are the same. The results obtained both for carbon and for oxygen corroborate those already published by Hewlitt, who used carbon (in the form of graphite) and liquid oxygen.

The absorption coefficients of water and six organic liquids were measured for X-rays of wave-lengths ranging from 0·2 to 0·98 Å. The variation with wave-length was found in all cases to be in accordance with the equation $\mu = A + B\lambda^3$ where for water, benzene, toluene, xylene, mesitylene, heptane, and cyclohexanol the values for A are 3·5, 15·3, 19·0, 21·7, 24·2, 21·5, and 20·5 respectively, and those for B are 44·5, 74·9, 85·3, 98·3, 113·6, 87·3, and 121·0 respectively. These values give the coefficients for a gram molecule of each liquid in a cell one square centimetre in cross-section. E. A. O.

1401. *Development of X-Ray Photographs, and the Use of Strengthening Screens.* **E. Schlechter.** (Phys. Zeits. 24. pp. 29–35, Jan. 15, 1923.)—The first part of the paper deals with the action of different developing reagents on various types of plate; the second part treats of the action of sheets of metal foil in increasing the blackening for a given exposure. This increase takes place whether the X-rays pass through the foil to the photographic plate, or first through the plate and then through the foil; in certain cases the first method gives the best result and in others the second. The foil is made of an alloy containing tungsten, and the extra blackening produced is due to absorption of X-rays by the tungsten, which converts their energy into that of fluorescent light. The effects of varying the wave-length of the X-rays by using the K-rays of different elements, and of varying the time of exposure, were studied. The relations are complicated, as the increase in blackening is not proportional to the time of exposure; but by making use of Schwarzschild's law of blackening the author succeeds in bringing the theory into agreement with the experimental results. H. N. A.

1402. *Images with Röntgen Rays.* **E. Fermi.** (N. Cimento, 25. pp. 63–68, Jan.–Feb., 1923.)—Experimental work on the lines of Gouy's suggestion [Abstract 201 (1916)] for obtaining monochromatic images by means of a mica cylinder. A. D.

1403. *Variation of the Intensity of Reflected X-Radiation with the Temperature of the Crystal.* **I. Backhurst.** (Roy. Soc., Proc. 102. pp. 340–353, Dec. 1, 1922.)—The work of W. H. Bragg [see Abstract 1840 (1914)] is extended to a variety of crystals and higher temperatures. General agreement only is found with the theories of Darwin and Debye. *Aluminium.*—A very marked decrease in intensity was observed with rise of temperature and fair agreement with Debye's theory obtained for the (100) and (222) spectra. *Carborundum.*—No deterioration of the crystal was observed up to 960° C. The decrease in intensity with rise of temperature was much greater for the higher order spectra and different curves were obtained for the K_α (333) and K_β (333) spectra. *Graphite.*—Only for the cleavage plane reflection was it possible to obtain a definite temperature-intensity curve, and for the direction perpendicular to this plane an unusually high coefficient of expansion was measured. *Diamond.*—No decrease in intensity was found that could be measured with certainty. *Ruby and Sapphire.*—An anomalous effect was observed since the decrease of intensity of the (111) spectra was greater than that of the (222). It is pointed out that this may be completely explained by assuming that the atoms of the aluminium pair remain in contact and do not share in the expansion of the lattice. E. A. O.

1404. *Optical Properties of X-Rays of Long Wave-Length.* **Holweck.** (Comptes Rendus, 176. pp. 570–573, Feb. 26, 1923.)—The author's experiments prove conclusively that it is possible to obtain the diffraction image of a slit using X-rays at less than 265 volts, and that it is possible to obtain a direct measure of the wave-length of the rays in a manner similar to that when ordinary luminous radiation is employed. Similar experiments were made to examine the reflection of X-rays from polished metal surfaces. A rapid decrease in reflecting power was noted as the wave-length of the rays was decreased. A. B. W.

1405. *X-Ray Generator.* **Saget.** (Soc. Franç. Élect., Bull. 3. pp. 43–54, Feb., 1923.)—The paper deals in the first place with the relations between X-ray spectra and the high-tension voltage supply generating the X-rays. The advantages of continuous high-tension current are pointed out and methods of production by means of rectified high tension a.c. are described. Details are given of a generator developing a constant potential of 250,000 volts. The best forms of X-ray tube and means of protection against X-rays are discussed, the paper concluding with a description of methods of measuring X-ray intensity. A. B. W.

1406. *X-Ray Tubes and their Construction.* **Johannès.** (Soc. Franç. Élect., Bull. 2. pp. 531–580, Dec., 1922.)—This gives a general résumé of the production of X-rays and the construction of X-ray tubes.

E. A. O.

RADIO-ACTIVITY.

1407. *On the Radio-Activity of Certain Springs in Roumania.* **P. Loisel** and **Michaïlesco.** (Comptes Rendus, 175. pp. 1054–1056, Nov. 27, 1922.)—The springs were situated in the neighbourhood of Orsova. The water of each spring showed great variation in its emanation content from day to day. The emanation content of one spring also differed greatly from that of another. The most radio-active water contained 0·73 millicuries per litre and the least active 0·19 millicuries per litre.

E. A. O.

1408. *Distribution of Path-Lengths of α-Rays.* **Irène Curie.** (Comptes Rendus, 176. pp. 434–437, Feb. 12, 1923.)—Photographic method employed with a Wilson apparatus, and α-rays from polonium. Curves given for the results. A. D.

1409. *On some α-Ray Tracks.* **C. T. R. Wilson.** (Cambridge Phil. Soc., Proc. 21. pp. 405–409, Feb. 8, 1923.)—Stereoscopic pictures of α-ray tracks were obtained by the cloud method. The pictures reproduced in the paper were obtained by spreading a small quantity of thorium oxide along a narrow strip across the middle of the floor of the cloud chamber and covering the oxide with black paper. From time to time an emanation atom ejects an α-particle, and within a small fraction of a second an α-particle is in turn ejected by the resulting Th-A atom. These events are shown in the reproduced photographs. Slow speed β particles (also termed fast δ-rays) appear as prominences on the α-ray tracks. They seem in general to be emitted nearly at right angles to the α-ray tracks. In none of the photographs do any δ-rays appear on the last 2 cm. of the α-ray tracks. If it be supposed that the range of δ-rays is proportional to the cube of their velocity as in the case of α-rays, and that the velocity of the δ-particle is proportional to the velocity of the α-particle which ejects it, then the maximum range of the δ-particle (which is about 0·5 mm. at 5 cm. from the end of the α-ray track) will only be about 0·1 mm. at 1 cm. from the end. A sharply defined α-ray track has generally a radius of about this magnitude so that near the end of the α-ray track the δ-ray would not project beyond the general cloud track.

The separation of the positive and the negative α-ray cloud tracks in the photographs reproduced are sufficiently nearly resolvable into their separate drops to suggest that it may be possible to apply the cloud method to the direct determination of the ionisation along the path of an α-ray. Another problem to which the method may be applicable is the determination of mobilities of the ions and in particular the separation of ions of different mobilities. E. A. O.

1410. *The Range of Alpha-Particles from Polonium in Various Gases.* **C. W. van der Merwe.** (Phil. Mag. 45. pp. 379–381, Feb., 1923.)—The range of the α-particles was determined by the Wilson ray track apparatus [Abstract 1544 (1911)]. The results, which are summarised in the following table, are in agreement with Bragg's law that the stopping-power of an atom is proportional to the square root of its atomic weight.

Absorbing Body.	Source of α-rays, Polonium.		Bragg's Experiments.		Range at N.T.P.
	Obs.	Calc.	Radium A.	Radium C.	cm.
Air	1·00	1·00	1·00	1·00	3·58
Hydrogen	0·22	0·26	—	0·24	16·28
Water-vapour	0·77	0·79	—	—	—
Methane	0·91	0·98	0·88	0·86	3·96
Nitrogen	0·99	0·99	0·98	0·99	3·62
Carbon monoxide	1·02	0·98	0·98	0·99	3·51
Oxygen	1·08	1·06	1·057	1·064	3·32
Nitric oxide	1·11	1·02	—	—	3·23
Carbon dioxide	1·52	1·51	1·49	1·51	2·36
Sulphur dioxide	1·82	1·80	—	—	1·97
Methyl bromide	2·04	2·08	2·03	2·09	1·76

E. A. O.

1411. *The Detonating Action of α-Particles.* **H. H. Poole.** (Roy. Dublin Soc., Proc. 17. pp. 93–95, Dec., 1922.)—It has been shown by Henderson [Abstract 2100 (1922)] that α-particles are capable of causing the detonation of iodide of nitrogen. From a series of observations described in the present paper it is concluded that the average number of particles per explosion is independent of the concentration (*i.e.* the number of α-particles striking a unit area of the salt per second). Also that the detonating efficiency of α-particles decreases with decrease of velocity. When fulminate of mercury, silver azide, dynamite, nitroglycerine, and potassium picrate were subjected to α-ray bombardment, no detonation occurred. The total number of α-particles involved in the tests amounted to about 10^{12}, which would have caused about 3000 detonations in iodide of nitrogen. The chance of an explosion of the above salts due to α-ray bombardment is therefore exceedingly small and probably zero. E. A. O.

HEAT.

1412. *An Improved Method for the Control of Temperature and other Physical Quantities.* **P. E. Klopsteg** and **W. H. Stannard.** (Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 179–186, Feb., 1923.)—A helix of thermostatic metal, consisting of a lamina of brass and one of invar, welded together, carried an electric contact on the end of a lever, where an iron armature was attached, which, being pulled down by an electromagnet as soon as contact was made, held the two contact pieces firmly together. A rotating interrupter in the same circuit, which also included the heater and was fed from the lighting mains, broke the circuit periodically, so that the magnet ceased to pull down the armature, and the thermally controlled contact could separate without any spark, if the temperature of the bath under control had risen enough to make this necessary. Sparking of the mechanically driven interrupter was diminished by means of a condenser, shunted across the break. The second member of the thermally controlled contact can be made in the form of a rotating cylinder, which makes the arrangement self-cleaning. A thermostat constructed in this way for works use was operated in a 5-litre bath, at about 100° C., during a period of ten consecutive days, except one Sunday; during this time the apparatus received no attention whatever, and ran eight hours a day, the temperature remaining within 0·05° C. of the average value and with few exceptions within 0·03° C. When the bath was suddenly cooled the regulator brought it back to the correct value in a very short interval. The same device can be applied to other forms of regulating apparatus. H. N. A.

1413. *A New Method for the Control of Thermostats.* **D. J. Beaver** and **J. J. Beaver.** (Indust. and Eng. Chem. 15. pp. 359–361, April, 1923.)—An electrical thermo-regulator capable of maintaining water or oil thermostats of capacities between 10 and 300 litres constant to within 0·001° C. over periods of months is described. The regulator is of the customary mercury-contact type, a very small current being maintained across the contact and amplified by means of a vacuum tube sufficiently to actuate a magnetic relay or other current-controlling device. For baths of 30 litres or more capacity, the relay points should preferably not make contact more frequently than twice per second. For smaller baths the period should be shorter. Details of a device whereby this may be effected and which eliminates sparking and back-lash at the mercury contact and excessive wear at the relay points are given. J. S. G. T.

1414. *Radiometer.* **Edith Einstein.** (Ann. d. Physik, 69. 4. pp. 241–254, Nov. 30, 1922.)—Revised theory, tracing the movements to thermal currents. Electrical analogies of the equations. A. D.

1415. *Temperature Measurements with the Einthoven Galvanometer.* **F. Adcock** and **E. H. Wells.** (Phil. Mag. 45. pp. 532–560, March, 1923.)—In conducting temperature measurements in a gas-engine cylinder by means of a platinum resistance thermometer, a discussion is given of the conditions affecting the temperature lag. The procedure adopted consisted in maintaining steady temperatures of different intensities in different regions of a vertical silica tube of which the upper part is wound with an electrical resistance heater and the lower part is enclosed in a box through which water can be circulated. The thermometer is reciprocated axially through these regions to obtain the cyclical variations of temperature, and the rate of variation of temperature is obtained by the frequency of movement of the thermometer. The resistance thermometer used consisted of a fine platinum wire which bridges two carrying wires, while a shorter length of the same type of wire connects a further two leads to serve as compensating circuit. The four leads are rigidly joined at each end to a frame connected with the oscillating mechanism. A Wheatstone bridge is arranged in which two arms are composed of the resistance wire and compensating circuit and the other two of adjusted resistances. An Einthoven galvanometer is connected between the two middle points of the four arms. The galvanometer readings are registered on a photographic plate which is allowed to fall so as to include two cycles of oscillation. The curves are compared with the readings given by the galvanometer when the thermometer is at rest in the different temperature zones. The discrepancy between the curves taken at speed and the stationary temperature distribution curves is termed the temperature lag, and is taken as a measure of the ability of the thermometer to follow the temperature changes. Measurements are made with different thicknesses of wire, different temperature ranges, and different speeds of oscillation. The ratio of temperature lag to temperature range is plotted for different conditions. It is concluded that, at atmospheric pressure and with comparatively quiescent air, the platinum resistance thermometer is not capable of following with sufficient accuracy temperature changes which take place with the rapidity which obtains in a gas-engine cycle. It is anticipated, however, in further experiments at present in progress, that the conditions obtaining in the gas-engine cylinder are much more favourable to thermometry, on account both of the higher pressures existing and also of the turbulence. J. N. P.

1416. *Determination of the Melting-Points of Highly Infusible Metals.* **M. Pirani** and **H. Alterthum.** (Zeits. Elektrochem. 29. pp. 5–8, Jan. 1, 1923.)—The melting-points of tungsten and molybdenum were determined, using a 7-mm. thick rod, pierced by a hole at right angles to the long axis. This hole was used as the "black body" for the purpose of temperature measurement, which was affected by a Holborn-Kurlbaum pyrometer. The rod was heated electrically, with gradually increasing current, and since the cross-section of the rod was smallest at the boring, melting was localised at this point. The results gave 3660 ± 60° C. for tungsten and 2840 ± 40° for molybdenum. F. J. B.

1417. *Specific Heat of Carbon, Silicon, and Carbide of Silicon at High Temperatures.* **A. Magnus.** (Ann. d. Physik, 70. 4. pp. 303–331, Feb. 22, 1923.)—No measurements appear to exist on the specific heat of silicon and carborundum at high temperatures, and further the old values for diamond and graphite obtained by H. F. Weber in 1875 do not appear to have the necessary accuracy. The method now employed by the author is that previously used [Abstract 208 (1916)], *i.e.* that of measuring the temperature difference between a large copper block placed inside a double-walled vacuum vessel and that of a large mass of water surrounding the vacuum vessel. The temperature difference was measured by means of a thermopile of 50 copper-constantan junctions, and by employing Diesselhorst's compensator a p.d. of 10^{-7} volt could be measured, and this corresponded to 1/20,000° C. The large copper block served as the calorimeter into which the hot substance was placed. The results of the investigation are collected in tables, and are divided under three heads, *i.e.* (1) Observations with the empty containing vessels; (2) observations with a water-filled vessel for calibration purposes; (3) observations with the desired materials. An interpolation formula giving the heat yielded by the substance in cooling from the initial temperature to 0° C. is obtained, the constants being calculated by the method of least squares. The graphite and silica were carefully examined for impurity, but the carborundum was not analysed. Many experiments were made on graphite, using two different ovens for heating purposes and two methods of measuring the temperatures in order to ascertain if concordant results could be obtained. A formula with 5 constants fitted the results very closely. In the case of Si, whose sp. heat changes less in the temperature interval used, 3 constants were found to be sufficient, but 5 were again necessary in the case of carborundum. The results for graphite are compared critically with those of Weber and the differences attributed to errors in his thermometers, and to the heating effect of the absorption of water by graphite, which, however, was measured by the author and found to be small.

For a theoretical discussion of the results which is given in the second part of the paper, it is necessary to calculate the sp. heat at constant volume. This requires a knowledge of the density, coefficient of expansion, and compressibility of the materials. These quantities are known for C and Si, but the coefficient of expansion for carborundum had to be obtained. This was determined carefully by the pyknometer method and found to be $2 \cdot 9 \times 10^{-6}$ and the density $3 \cdot 211$. To find C_v from C_p the approximate expression $C_p - C_v = AC_p^2T$ is used where $A = 9a^2M/C_p^2K\rho$ and T = abs. temp., a = co-efft. of expansion, m = atomic or molecular weight, K = compressibility, ρ = density. The values of C_v thus obtained are expressed in Debye's temperature functions, and it is found that for diamond and silicon-carbide only one value for the characteristic temperature θ is required, but for graphite a formula for 2 values of θ must be used. This is accounted for by the arrangement of the atoms in the crystal. In the case of Si, when making the correction from C_p to C_v the compressibility worked out at $0 \cdot 42 \times 10^{-12}$ dyne^{-1} cm., while Richards' value was only $0 \cdot 16 \times 10^{-12}$. Graphs are given of the specific heats of diamond and graphite, and these are seen to coincide from 700° C. onwards. This is in agreement with Weber's suggestion that the difference in the specific heats of the two forms of carbon should vanish at a red heat. The Kopp-Neumann rule is discussed in connection with carborundum, and the rather unexpected results are referred to the presence of different kinds of atoms in the space lattice.

T. B.

1418. *Study of the Specific Heat of the Saturated Vapour of Benzene, and the Adiabatic Curve of the Liquid-Vapour Mixture.* **G. Bruhat** and **A. Delaygue.** (J. de Physique et le Radium, 4. pp. 1–10, Jan., 1923.)—It is known that the specific heat *m'* of the saturated vapour of certain bodies shows two points of inversion; at low temperatures and near the critical point m' is negative, while in the interval between these two points m' is positive. The inversion points have been recently observed [Abstract 1650 (1922)] by the present authors in the case of benzene, by the study of its condensation by expansion or compression in a Cailletet apparatus. Thermodynamic formulæ allow the calculation of the various calorimetric constants of a fluid, when the characteristic equation is known and a particular value of one of them for each temperature. The law of corresponding states is not sufficiently exact for application to every substance. For benzene it gives values of temperatures of inversion of 155° and 245° C. in poor agreement with experimental values. A new characteristic equation has therefore been developed which has been found to give much better agreement with experiment in the calculation of the specific heat of benzene. The equation

$$[p + a/\mathrm{T}(v + 3b)^2]\,(v \times b) = \mathrm{RT}$$

may be put in the "reduced" form

$$\left[p' + 16/3\mathrm{T}'\left(v' + \frac{1}{3}\right)^2\right]\left(v' - \frac{1}{a}\right) = 32\mathrm{T}'/9$$

where $p' = p/p_c$, $v' = v/v_c$, $\mathrm{T}' = \mathrm{T}/\mathrm{T}_c$, where the critical constants for benzene are $p_c = 47{\cdot}9$ atmospheres, $\mathrm{T}_c = 561{\cdot}5°$ abs., $v_c = 3{\cdot}284$ c.c. Values are thus obtained for the specific heat C of the vapour, and for m' that of the saturated vapour. The variation of m' with the temperature is given in tables and in a curve. The upper point of inversion is obtained from this curve as 254°, in good agreement with the experimental value 258°. The method just given appears unsuitable for the calculation of the lower point of inversion. This is evidently due to the imperfection of the characteristic equation. In order to calculate this the equation $m' = m + d\mathrm{L}/d\mathrm{T} - \mathrm{L}/\mathrm{T}$ is taken as the starting-point. Hence $m' = d\mathrm{L}'/d\mathrm{T} - \mathrm{L}/\mathrm{T}$ where L' is the total heat of vaporisation. In order to calculate $d\mathrm{L}'/d\mathrm{T}$ an empirical formula due to Regnault is used, *viz.* $\mathrm{L}' = 109 + 0{\cdot}24429t - 0{\cdot}0001315t^2$. Also, $\mathrm{L}^2 = 42(561{\cdot}5 - \mathrm{T})$. Hence, $m' = 0{\cdot}31609 - \sqrt{42(561{\cdot}5 - \mathrm{T})}/\mathrm{T} - 0{\cdot}000263\mathrm{T}$. This gives a lower inversion point 121°, in excellent accord with the experimental value 122°. The calculated values of the specific heat of the saturated vapour of benzene are then employed for the numerical calculation of the variation of the entropy of the saturated vapour of this substance between ordinary temperatures and the critical point, the entropy S of the liquid being obtained from a combination of the equation $\mathrm{S} = \int_{\mathrm{T}_0}^{\mathrm{T}} m'd\mathrm{T}/\mathrm{T}$ and the last equation above. Temperature-entropy diagrams are then constructed, and these, in conjunction with the tables of S. Young, permit the construction of adiabatics of the liquid-vapour mixture in ordinary coordinates, either volume-pressure or volume-temperature. T. B.

1419. *The Specific Heats of Nitrous and Nitric Oxides.* **J. R. Partington and W. G. Shilling.** (Phil. Mag. 45. pp. 416–430, March, 1923.)—Correct values of these specific heats are of special interest from the point of view of the Lewis-Langmuir theory. This is particularly the case with N_2O, since this gas has an external electronic structure identical with that of CO_2. Results previously obtained vary from 1·25 to 1·30. The method employed is similar to that described in a former paper and 1559 (1914) [Abstracts 1157 (1922)], with one or two modifications, and consists in determining the relative velocities of sound in the gas and in dry air under the same conditions. The use of dry air, free from carbon dioxide, is shown to be necessary. It is also shown that it is necessary to eliminate the effect of the tube itself on the velocity of sound in the gas contained in it. Employing Berthelot's equation of state as the basis of calculation [see Abstract 1157 (1922)] the following results were obtained: Nitrous oxide at 12·2° C., $C_p = 8\cdot 799$; $C_v = 6\cdot 758$; $C_p/C_v = 1\cdot 302$. Nitric oxide at 7·6° C., $C_p = 6\cdot 890$; $C_v = 4\cdot 993$; $C_p/C_v = 7\cdot 400$. T. B.

1420. *Reduction of Vapour Pressure due to Solution of Certain Metallic Salts in Water at* 0° *C.* **C. Dieterici.** (Ann. d. Physik, 70. 8. pp. 617–621, April 20, 1923.)—In continuation of previous work [Abstracts 818 (1898) and 843 (1899)], the author has determined the respective vapour pressures of aqueous solutions of cadmium sulphate, chloride and nitrate, zinc sulphate and nitrate, and nickel sulphate, nitrate, and chloride, the concentrations employed ranging up to about 2N. The results were compared with the respective vapour pressures of equally concentrated aqueous solutions of non-electrolytes, *viz.* sugar and urea. The results indicate that the respective vapour pressures of the dilute solutions of sulphates, up to about 2N, are greater than the respective vapour pressures of the corresponding non-electrolytic solutions. The vapour pressures of the solution of electrolyte and non-electrolyte are equal at a concentration about equal to 2N. Above this concentration, the diminution of pressure is greater in the case of the electrolytic solution. The behaviour of solutions of magnesium sulphate is similar, but in this case the range of concentrations exhibiting abnormal values of vapour pressure is smaller. The behaviour of solutions of nitrates is normal, the vapour pressures being in all cases considerably lower than the corresponding value for the solution of non-electrolyte. A similar result holds in the case of the solutions of chlorides, but the reduction of pressure in these cases is not so great as in the case of the nitrates. J. S. G. T.

1421. *Distribution of Temperature in Heating Appliances.* **Bosch.** (Schweiz. Elektrot. Verein, Bull. 14. pp. 193–202, April, 1923.)—The paper, after some preliminary remarks concerning the influence of the war in causing numerous changes in methods of heating and in the origination of new methods, discusses the electrical generation of heat. Fourier's equations for the conduction of heat in a plate are employed to determine the distribution of temperature in four cases, *i.e.* when (1) heat is taken in at both surfaces; (2) heat is given off at both surfaces; (3) heat is taken up at one surface and given out at the other; (4) when the flow of heat in (3) is reversed as regards the two surfaces. The transcendental equations involved are solved graphically. One example of a plate 20 cm. thick heated on one side by gas at 420° C., the other side being initially at 20° C., is worked out in detail. T. B.

1422. *Restricted Movements of Molecules at very Low Pressures.* **H. H. Platt.** (Phil. Mag. 45. pp. 414–415, March, 1923.)—It was recently shown by A. Fairbourne [Abstract 2110 (1922)] that tapered

vessels, open at both ends, whose dimensions are smaller than the free path of many of the molecules of the gas employed, might be expected to cause an appreciable flow of gas emerging from the larger end of the vessel. Fairbourne proposed to mount a small vane within or below this opening for the detection of this flow. It is pointed out that the corresponding reaction against the vessel itself opposite in direction to the gas flow might be used in order to detect the movement in question. This could be done by perforating a thin plate with a large number of tapered apertures pointing in opposite directions on the two sides of the plate. If the plate is then pivoted at its middle point, and suspended in a gas-filled vessel in which the pressure is gradually reduced, it should start rotating when the molecular paths have grown in length until the selective action becomes appreciable. Obviously this apparatus is capable of far greater delicacy than the one originally proposed.
T. B.

1423. *Distribution of Molecules in a Gaseous Mass.* **J. Haag.** (Comptes Rendus, **176.** pp. 372–375, Feb. 5, 1923.)—Expressions given for the distribution, having regard to the size of the molecules; application to van der Waals' gases.
A. D.

1424. *Vapour Pressure of Pure Argon.* **F. Born.** (Ann. d. Physik, **69.** 6. pp. 473–504, Dec. 19, 1922.)—In argon freed from N and O by passing over melted calcium, the vapour-pressure curve agrees with Nernst's approximative formula. The divergencies in Crommelin's data are explained. The true chemical constant agrees fairly with the Stern-Sackur theory, but with a divergence in the same sense as that of Hg. Vapour pressures tabulated.
A. D.

1425. *Kinetic Interpretation of the Van't Hoff Law.* **C. E. Guye.** (Comptes Rendus, **176.** pp. 835–838, March 19, 1923.)—It is customary to consider the resultant dissociating action of molecular collisions as a function of the relative energy of collision. This condition, however, does not appear sufficient, although often adopted in the kinetic theory. The intensity of the forces developed during collision and that during their period of activity should be equal, but in the case of electrolysis the disposable energy of the source is insufficient to condition the phenomenon, and the electromotive force of the source must exceed the polarisation tension. The author has shown previously [Abstract 935 (1923)], that on the assumption of a dissociating action as a function of the impulse of the forces developed during the collision in conjunction with Maxwell's law of distribution of velocities compatible with the thermal equilibrium, an expression may be deduced for the number of dissocia parietatingl collisions per unit of surface in unit time, and also for those between molecules. The numerical discussion of these formulæ has shown that the dissociating action due to parietal collisions is incomparably greater than that due to molecular collisions, so long as the parietal collisions are ideally elastic. On the contrary, if the molecules which strike the wall transfer all or an appreciable portion of their kinetic energy, then the dissociating effects produced in the mass of the gas outweighs those at the surface. These considerations may help to explain the mechanism of surface catalysis, but the special object of this paper is to show that the hypothesis as previously developed gives a quantitative interpretation of the van't Hoff approximation law that in the vicinity of ordinary temperature, a rise of 10° C. suffices to double the speed of a reaction. Formulæ are developed and illustrative data supplied for hydrogen. H. H. Ho.

1426. *A Study of Certain Problems in Kinetic Theory for the Hypothesis where the Intermolecular Force is any Function of the Distance.* **J. Haag.** (Comptes Rendus, 176. pp. 32–35, Jan. 3, 1923.)—Previous mathematical study of viscosity, thermal and electrical conductivity, and diffusion, assumed intermolecular action inversely proportional to a power of the distance, and the present investigation is for the general case of any function whatever, employing an extension of Boltzmann's method as revised by Jeans in his "Dynamical Theory of Gases" (ch. viii). The investigation is limited to the case where one gas is infinitely light and rarefied as compared with the other. The paper is entirely mathematical, and it is found that whatever may be the law of intermolecular force, the ratio of the coefficient of diffusion to that of electrical conductivity is proportional to the temperature and to the molecular weight of the rarefied gas and inversely proportional to its density. H. H. Ho.

1427. *Differential Equation of State at High Pressures.* **V. Fischer.** (Ann. d. Physik, 69. 4. pp. 315–324, Nov. 30, 1922.)—Equilibrium diagrams for CO_2 show that for increasing p and decreasing T the variation of the specific heat C_p with pressure becomes less, so that, $C_p \doteqdot F(T)$, or $(\partial c_p/\partial p) = 0$. By means of the known relation

$$(\partial c_p/\partial p)_T = -AT(\partial^2 v/dT^2)_p,$$

this can be reduced to the form $T(\partial v/\partial T)_p = Tf(p) = v - b$, where b is a constant. This equation is fully justified by E. H. Amagat's tabulated researches (Ann. Chem. Phys. 29. p. 506, 1893), but further investigations will be required to determine its range of validity. It should be possible, by means of this equation, to determine approximately the specific volume of a substance at an infinitesimal temperature.

G. W. de T.

1428. *A New Modification of the Equation of State of a Gas.* **A. Leduc.** (Comptes Rendus, 176. pp. 830–833, March 19, 1923.)—In a former paper [see Abstract 167 (1922)] the integration of the equation of internal pressure in reduced coordinates, $\mathfrak{T}\partial\mathfrak{P}/\partial\mathfrak{T} - \mathfrak{P} = F4\chi$, has given $\mathfrak{P} = 8\mathfrak{T}/(3\mathfrak{V} - 1) - \mathfrak{T}(4\chi - 1)/\mathfrak{V}^2$. In this equation $\mathfrak{P}$ is the internal pressure calculated on the author's experiments at pressures of the order of one atmosphere, χ being the reciprocal of the reduced temperature, and F a function of $\mathfrak{V}$ which becomes $K/\mathfrak{V}^2$ for sufficiently large values of $\mathfrak{V}$.

Assuming the constancy of the co-volume, the integration of the first equation above gives $\mathfrak{P} = 8\mathfrak{T}/(3\mathfrak{V} - 1) - \mathfrak{T}(4\chi - 1)/\mathfrak{V}^2$. This equation, however, is applicable, in the case of large volumes, only to oxygen, where the reduced constant $\mathfrak{R} = RT_cD_c/Mp_c$ is sensibly equal to 8/3, as required. In order to render it applicable to large volumes in general it is necessary to replace D_c by $D_c' = 8Mp_c/3RT_c$. This gives, in ordinary coordinates, $p = rT[1/(v - a) - 9a(4\chi - 1)/8v^2]$, the co-volume having the value $a = rT_c/8p_c$. The coefficient of dilatation, as given by

$\beta = (1/p_0)(\partial p/\partial T)$, and the reduced temperature $\mathfrak{T}_1$ give agreement with experiment in the cases of SO_2 and N_2.

These formulæ, however, in common with those of van der Waals and others, have two faults: (1) They lead to a density of the fluid not greater than $3D_c$, while experiment gives densities up to $4 \cdot 6\ D_c$; (2) They assume the co-volume constant, while modern ideas admit that the co-volume increases with v. These two discrepancies disappear, however, if the integral of the first equation given above is taken as $\mathfrak{P} = \mathfrak{R}'\mathfrak{T}\mathcal{V}/(\mathcal{V} - \mathfrak{A})^2 - \mathcal{K}\mathfrak{T}(4\chi - 1)/\mathcal{V}^2$, or with ordinary coordinates with $D_c' = \mathfrak{R}p_c/rT_c$ we have $p = rT\left\{v(v - a)^2 - 1 \cdot 946a(4\chi - 1)/v^2\right\}$. Other modifications proposed in order to bring theory into accord with experimental evidence are to replace $\mathcal{V}^2$ by $(\mathcal{V} + \mathfrak{A})^2$ or by $(\mathcal{V} + n\mathfrak{A})^2$, n being chosen as 8 to give $\mathfrak{R} = 3 \cdot 665$ which is near the value (11/3) given by the "normal" series. An equation of state is thus obtained giving reasonable values from low pressures up to the critical point.

T. B.

1429. *The Meaning of "a" and "b" in the Equation of State.* **A. F. Core.** (Phil. Mag. 45. pp. 622–624, March, 1923.)—In the second part of a recent paper [see Abstract 1656 (1922)] Fowler calculates the value of van der Waals' "a," and the present author takes exception to his method. The general virial equation, so far as the second virial term, is $pv = RT + B/v$, but except under certain conditions, even when the molecules contain perfectly hard kernels, B/v does not naturally fall into 2 parts corresponding to RT b/v and a/v, *i.e.* into 2 parts, one of which is proportional to and the other independent of the temperature. Therefore, to separate B/v into 2 parts, it is necessary to define either a or b. Now a/v may be defined as half the work required to abstract N mols. chosen at random from the interior of the gas to infinity outside the gas. This definition is, however, ambiguous, but the latter is removed by stating that when a molecule is being removed the other molecules are to be considered fixed in position. a/v can then be calculated when the equation of state is known and expressed directly in terms of the molecular field, the potential energy per gram. mol., being given by

$$-a/v = 2\pi N^2/v \int_0^\infty r^2 \chi e^{-\chi/kT} dr,$$

in which χ is the potential of one molecule at a distance r from the centre of another. This a/v so defined, corresponds most closely with that of van der Waals' equation, and the remainder of the 2nd virial term may be called RTb/v. This cannot be called the collision virial, for when the molecules contain a hard kernel it does not in general reduce to the collision virial of Reinganum. Perhaps the best description would be the potential and non-potential parts of the second virial term. When the gas is sufficiently rarefied, so that the variation in density towards the boundary can be neglected, the a/v thus defined must equal the entire term B/v. When the molecules contain a hard kernel this definition of a/v may be modified by excluding from this term that part of the work done by the impulse forces arising on collision, and the division of B/v must be the same as that of Reinganum, *i.e.* RTb/v is due to the collision impulses.

H. H. Ho.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1430. *Propagation of Electromagnetic Waves.* **O. Laporte.** (Ann. d. Physik, 70. 8. pp. 595–616, April 20, 1923.)—Various formulæ relating to the propagation of electromagnetic waves at the earth's surface are examined and compared. W. A. R.

1431. *Electron in Uniform Motion.* **H. Bateman.** (Science, 57. pp. 238–240, Feb. 23, 1923.)—On the theory of Abstract 187 (1923) the mass inside an electron in uniform motion, when calculated from the momentum, is equal but opposite in sign to the mass outside. Discussion of the theory referred to. A. D.

1432. *Theory of the Schrot Effect.* **L. S. Ornstein and H. C. Burger.** (Ann. d. Physik, 70. 8. pp. 622–624, April 20, 1923.)—The authors advance a short mathematical analysis of the theory of the Schrot effect [Abstract 731 (1923)] alternative to those proposed respectively by Schottky [Abstract 332 (1919)] and by Fürth [Abstract 541 (1923)]. J. S. G. T.

DISCHARGE AND OSCILLATIONS.

1433. *Some Photoelectric Experiments on Platinum Relating to the Influence of Gases.* **L. A. Welo.** (Phil. Mag. 45. pp. 593–609, March, 1923.)—Among the problems in connection with the photoelectric effect, none appear to have led to such conflicting experimental results and thence to so wide a difference of opinion as that concerning the influence of gases. Previous work is quoted by various investigators, including Sende and Simon [see Abstract 630 (1922)] and the present author [see Abstract 72 (1919)]. The experiments now described may be regarded as in continuation of those previously reported upon, under improved experimental conditions. The original aim was twofold: (1) To work in much higher vacuo to eliminate possible effects of residual gases. (2) To use two extreme wave-lengths for which platinum is sensitive rather than the total radiation; making possible, not only conclusions as to the manner in which gas affects the photoelectric effect, but also as to the structure of the adsorbed layer. As the work proceeded, it became apparent that time is quite as important a factor in the removal of occluded and adsorbed gases as high temperatures and high vacua. Accordingly, heating-current–photo-current curves were obtained after the platinum had been heated in a vacuum for a very long time. Full experimental details are included. The wave-length limit proved to be constant, but the largest variations in sensitiveness took place with radiation of long wave-length. It is concluded that the primary emission from the platinum is constant, but that an adsorbed layer of gas, whose effectiveness depends on the temperature of heating, stops the electrons of low velocity. The evidence is considered to be in favour of the transition layer theory of adsorption, and decisively against the view that the adsorbed gas consists of a single layer of molecules. The type of curve becomes very different after the foil has been heated at as high a temperature as possible for a time of 9 hours or more. The minima of the original curves do not appear. The sensitiveness never approaches zero, and the photoelectric property is primarily that of the platinum itself, the gases merely modifying and always reducing the effect. The minima of the original or repetition curves could not be reintroduced by letting the gas-free foil stand in various gases. They were reintroduced by heating with a blow torch. The minima of the curves are qualitatively explained in a simple manner by considering the driving off of gas as involving two distinct processes. In the first, the gas is brought to the surface by diffusion, and in the second it must be released. At each heating-current or temperature, with given gas concentration in the metal, a gas layer of characteristic thickness or density brings about the equilibrium adjustment. **H. H. Ho.**

1434. *Theoretical Considerations with Respect to the Deflection of Free Slow Electrons in Atoms.* **F. Hund.** (Zeits. f. Physik, 13. 4. pp. 241–263, 1923.)—Lenard made the observation that the free paths of electrons in gases decrease from the values at high velocities to a special limiting value on passage to slower electrons, depending on the particular gas. The experiments of Ramsauer [see Abstract 996 (1921)], and of Mayer and Hertz, have afforded the unusual result that with argon the free path below 12 volts again increases and below 1 volt has attained 10 times its value for 12 volts. None of the gases H_2, He, Ne, N_2, or CO_2 show this effect, He alone exhibiting a tendency thereto. Minkowski and Sponer have recorded abnormal behaviour for krypton. Townsend and Bailey have calculated that the free path is a function of the average velocity of the electrons in argon for velocities at about 0·15 volt with a maximum free path at about 0·4 volt. When the conceptions of electro-dynamics are applied to atomic processes, an electron coming within the electrical field of an atom experiences a deflection through the influence of the electrostatic attraction between nucleus and electron, and a loss of energy by radiation in consequence of the acceleration. This loss becomes more appreciable the greater the deviation, and greatest when the electron possesses the smallest amount of energy. Below a certain velocity the energy loss by radiation would exceed the kinetic energy and the electron be unable therefore to leave the atom, but move in ever diminishing orbits round the nucleus which it must finally enter. In order to remove such a contradiction to experience it must be assumed (based on experiments) that the energy radiation is much smaller than the calculated value, and can be neglected for slow electrons, although the laws of electrical attraction must remain valid. With these assumptions it is, however, impossible that the influence of the force field in the argon atom is weaker on slow electrons than on the more rapid, so that the slower electrons penetrate the atom without deflection. The present investigation deals with this problem, and attempts to find a force field which will produce a deflection of 2π for almost all electrons within certain low velocities, since under the assumption of such a force field difficulties arise; the second part of the paper attempts to reconcile discrepancies between classical results and experience. Part I deals with motion from the electrostatic standpoint and Part II considers, the assumption of the rectilinear passage of very slow electrons. The conclusions are as follows: By impact of an electron with an atom under the influence of the atomic force field there arises a transition probability from the rectilinear path to one of smaller energy. The new path is likewise rectilinear and the energy difference is radiated according to the $h\nu$ relation, the maximum frequence being given by $h\nu_{\max.} = \frac{1}{2}mv^2$, the kinetic energy of the electron before impact. The transition probability of electrons in other orbits may only reach such a value that for zero frequency a greater intensity obtains than corresponds to the classical radiation. These considerations are similar to those of Kramer for the emission of the continuous Röntgen spectrum. For slow electrons there is an approximation that the transition probability becomes quickly of low value with decreasing electronic velocity. A large fraction of the slow electrons will therefore afford no radiation after impact and remain in their stationary orbits. The chief hypothesis which is assumed for the explanation of large free paths is that all electrons which experience no transition are uninfluenced by impact and continue their former courses. This view deviates from the usual laws of electrostatics, but is not contrary to the use of electrostatics in the Bohr atomic model, since here the electrostatic application is only valid for the closed quantum orbits around the nucleus. For the impact of an electron with a normal atom without electronic affinity, such quantum orbits are no longer possible, and before and after impact only rectilinear stationary orbits exist. Between these a quantum transfer occurs for which the classical laws are not valid as with the Bohr atom. H. H. Ho.

1435. *Positive Rays in Simple Gases.* **J. J. McHenry.** (Phil. Mag. 45. pp. 433–443, March, 1923.)—The paper outlines a series of investigations of the variation of the ratio of atomic and molecular positive rays of simple gases, under varying conditions of pressure, etc., in the discharge tube. J. J. Thomson has suggested that such a study would probably throw light on the nature of ionisation by kathode rays and the positive rays themselves, and also give some information on dissociation and the forces that bind the atoms in a molecule together. J. J. Thomson's positive ray apparatus (giving a series of parabolas when rays deflected by magnetic and e.s. fields) was employed. It is shown that the presence of mercury-vapour in the discharge tube has a considerable influence on the relative numbers of atomic and molecular positive rays in oxygen. The pressure of the gas in the tube and the voltage at which the rays are generated have also a very important influence on the ratio. The production of atomic positive rays near the kathode is very noticeable at high pressures, but, even at the very highest pressures used, the faster positive rays are mostly molecular. Similar experiments were made with oxygen, hydrogen, mixtures of O_2 and H_2, and CO. In the case of CO the proportion of atomic kanalstruhler is much greater than with pure oxygen under similar conditions. A. B. W.

1436. *Thermionic Effects due to Cæsium.* **I. Langmuir** and **K. H. Kingdon.** (Science, 57. pp. 58–60, Jan. 12, 1923.)—On a tungsten filament, cæsium in the tube at 25° forms an adsorbed film, one atom thick even at 600° C. or more. The stability of the film is due to the electron affinity of a tungsten surface (4·52 volts) being greater than that of cæsium ions (3·90 volts); a cæsium atom approaching a tungsten surface is deprived of its valency electron, becomes positively charged, and is detained by the negative charge induced on the tungsten. If there be traces of certain electronegative gases, an additional film of these is adsorbed, and the cæsium film is stable up to 900° C.; then the saturation current is about 0·3 amp. per cm.^{2} of filament surface. At temperatures below 900° the saturation current is

$$i = 60 \cdot 2\ T^2 \epsilon^{-b_0/T} \text{ amps./cm.}^2,$$

where $b_0 = 16{,}000°$ whether the cæsium layer be outside or inside the film of electronegative gas. At higher temperatures the cæsium layer is evaporated, at first as cæsium atoms then as cæsium ions; and the saturation current falls. **A. D.**

1437. *Canal Rays.* **H. Baerwald.** (Ann. d. Physik, 70. 3. pp. 255–256, Feb. 15, 1923.)—Correction of error (200 for 200 v.) in former paper [Abstract 1780 (1921).] **A. D.**

1438. *Secondary Electron Emission from Cu and CuO.* **L. E. McAllister.** (Phys. Rev. 21. pp. 122–130, Feb., 1923.)—The number of secondaries per primary increases very rapidly with the velocity of impact for plate voltages between the ionisation potential of the surface and 300 volts; for higher voltages the number increases more slowly, but still continues to increase at 750 volts. The parts of the plate directly in front of the holes in the grid become thinly coated with CuO; the thicker the layer the greater the emission, and the greater the ionisation-potential. The amount of secondary emission is not affected by the temperature up to 450° C. There are a few electrons which are reflected or re-emitted with velocities comparable with those of the primary electron stream. **A. D.**

1439. *Luminescence Phenomena and their Technical Utility.* **F. Schröter.** (Zeits. techn. Physik, 4. 4. pp. 162–175, 1923.)—This investigation is a continuation of a previous one [see Abstract 1120 (1923)]. Section VI dealing with the production of light by electronic impact in dilute vapours, and Section VII considering solid and liquid luminescent radiators as sources of light under the sub-sections of photo and radio luminescent bodies, and chemo-luminescent reactions. The suitability of luminescent radiators for economic light sources has been theoretically established. By activation of resonance radiation in monatomic vapours through the impact of slow electrons, the energy dispersion by non-radiation processes and molecular rotation at sufficient dilution are found to be no longer essential effects, so that a high degree of efficiency can be expected. The space charge, however, limits the attainable current densities to values of the dimensional order 10^{-8} to 10^{-11} A/cm.^{2}, and in consequence the range of such lamps is determined by the dimensional problem. In an investigation into the possibilities of solid and liquid luminescent radiators, the non-radiation processes are to be made responsible for the small intensity values and utility effects in photo and chemo-luminescence. The most favourable outlook will be afforded by a chemo-luminescence procedure, which may be realised by means of purely chemically or electrolytically working lamps, if molecules can only be found possessing those properties of the active luciferin in the luminous animal organisms, in which oxidation effects are almost entirely manifested in the form of radiated light. H. H. Ho.

1440. *Ionisation by Collision of H, N, Ar.* **T. L. R. Ayres.** (Phil. Mag. 45. pp. 353–368, Feb., 1923.)—X = field strength, volts/cm.; p = gas pressure, mm.; a = distance apart of electrodes in cm.; v = max. voltage-difference employed; α, β = the number of pairs of ions produced per cm.^{3} by collision, by one negative or one positive ion respectively. With hydrogen and nitrogen the values obtained for (α/p) and (β/p) are in good agreement with Townsend's and Hurst's; for nitrogen in the range $(X/p) = 100$ to 350, the values of (α/p) are slightly higher and those of (β/p) are lower than Hurst's; effect of electrons observed for values of (X/p) as low as 5 in hydrogen and 10 in nitrogen; no distinctive variation in the ionisation due to *slight* contamination of these gases; the nature of the metal used for electrodes has no appreciable effect. With argon, values of (α/p) and (p/p) at higher values of (X/p) agree generally with earlier results, but for lower values of (X/p) are smaller; effect of electrons observed for values of (X/p) as low as 2; effect of positive ions measurable with pure gas down to $(X/p) = 10$, but with slight contamination not below $(X/p) = 20$; in region $(X/p) = 2$ to 10, slight impurities may reduce the effect of the electrons to one-fifth; the sparking potentials were comparatively low, and impurities increased the sparking potential. A. D.

1441. *Intensity of Light from Positive Rays.* **W. Wien.** (Ann. d. Physik, 70. 1. pp. 1–31, Jan. 18, 1923.)—This is a mathematical treatment of the intensity to be expected from statistical considerations. The nature of the collision between a moving atom and a molecule at rest is discussed. A distinction is made between the mean free paths of excited and unexcited atoms, etc. The treatment is based on an earlier paper [see Abstract 1147 (1923)]. It is considered that a positive ray is made suddenly to pass from a region of one pressure to another at a higher pressure. A simplification is possible, due to the fact that certain of the paths may be taken as inversely proportional to the pressure, and the intensity of the emitted light is taken to depend on the duration of time in which the process of emission continues. It is shown that the intensity J is given by $J = \text{const.}\ e^{-x/l}$, where l is a mean free path, and x is measured along the ray.

The experimental part consisted in measuring the blackening of a plate in a quartz spectrograph when positive rays streamed through a narrow slit into an observation chamber having a different pressure. Observations were made on the same plate for different pressures in the observation chamber. Curves were obtained for hydrogen in hydrogen and for hydrogen in nitrogen (*i.e.* the second gas at rest in the observation chamber). For dealing with higher pressures the apparatus was improved; a Gaede pump and three diffusion pumps were used to maintain the vacuum in the discharge tube, and ten diffusion pumps were employed close to the slit dividing off the observation chamber so as to prevent the gas streaming through the slit from raising the pressure in the discharge tube unduly. In this way hydrogen positive rays could be made to enter nitrogen at rest at a relatively high pressure. The higher the pressure of the nitrogen, the greater the intensity of the hydrogen lines. It is considered that the values of the free paths obtained are to a first approximation in agreement with the theory. Comparison with Vegard's results [see Abs. 113 (1913)] shows that the free path calculated from them is about three times as great. A. C. M.

1442. *Cold and Hot Electron Discharges.* **W. Schottky.** (Zeits. f. Physik, 14. 2. pp. 63–106, 1923.)—Richardson's assumption of work required to overcome the electrostatic surface field at the surface of metals, and of the ideal gaseous state of the electrons in the interior of metals, are used in discussing a number of phenomena. The course of the potential change due to these surface fields is considered, partly by extrapolation and partly by means of models, and lead to voltage changes of the order of 10^8 to 10^9 volts per cm. for the passage of an electron from the interior of the metal to the exterior. The effect of an external field in diminishing the energy required for exit, and increasing the current, is discussed; and the passage from incandescent electrode emission, without field, to cold discharge, with very strong fields, is theoretically explained. The influence of submicroscopic irregularities of the surface (between 10^{-8} and 10^{-5} cm.) with strong fields ($>10^6$ volts/cm.) is discussed. The maximum strength of field at exposed points on the surface may be taken as about ten times as great as would be calculated from the microscopically determined dimensions of the surface. It is possible that positive ions are involved in Lilienfeld's auto-discharge of electrons. F. Rother's discharge, with minute distances between the electrodes, depends in part on electronic point action. The action of a certain class of crystal detectors is discussed qualitatively, on the assumption that the exit work varies in magnitude and "steepness." The curves deduced agree with the measurements of Huizinga, 1920. With differences of potential of about one volt the change from complete non-conductivity to complete conductivity takes place at immeasurably small distances (about 10^{-8} cm.). This face, and the point theory, lead to a theory of the action of the microphone. The resistance "per point of contact" is of the order of 10^7 ohms for carbon and 10^3 ohms for platinum. A plausible assumption as to the number of points of contact shows why good conductors are not suitable for microphones. The difference between detector action and microphone action is discussed more closely; and it is concluded that detector action depends on the existence of an atomic non-conducting layer. Finally, the whole theory is considered from the point of view of the quantum theory as applied to atomic structure. H. N. A.

1443. *Formation of Helium and Neon in Geissler Tubes containing Hydrogen.* **A. Piutti.** (Zeits. Elektrochem. 28. pp. 452–453, Nov. 1, 1922. Paper read at Deut. Bunsen Gesell., Leipzig, Sept., 1922.)—In seventy experiments under different conditions with Geissler tubes charged with hydrogen, no trace of the D_3 helium line or the D_5 neon line could be discovered, in spite of variations in the size and separation of the electrodes, the nature of the current, etc. T. H. P.

1444. *Secondary Emission of Electrons in Incandescent Kathode Tubes.* **A. Goetz.** (Phys. Zeits. 24. pp. 35–48, Jan. 15, and pp. 53–63, Feb. 1, 1923.)—The paper deals with the secondary emission of electrons in high vacuum triode tubes discovered by Hull. There is a rapid rise in the anode current, when the anode potential is increased; but sooner or later a maximum is reached and the current diminishes, and in some cases changes sign, so that the anode apparently loses electrons instead of receiving them from the incandescent kathode; further increase of the voltage brings the curve to a minimum, after which it rises again. This is explained by assuming that the primary electrons from the kathode, falling on the anode, produce secondary electrons on its surface, which pass to the grid electrode, this being kept at a higher potential than the kathode. The author has investigated the laws which govern the emission, the relation between the form of the characteristic and the form and relative position of the electrodes, and the static phenomena in the tube. A specially designed experimental tube was used, provided with a ring-formed secondary anode surrounding the grid and kathode. A large number of characteristic curves were obtained, both the grid and anode voltages being varied; the greatest possible care was taken to obtain a perfect vacuum, which is essential for the proper observation of the effect in question. The author differs from Hull as to the function of the grid, which does not directly add to the energy with which the electrons strike the anode; this energy is derived in part from the heat energy of the kathode and in part from the change of potential from E_C at the kathode to E_A at the anode. The movement is braked by the action of the space charge about the kathode, and the function of the grid is to overcome this braking action. There are similar space charges about the anode, and round the grid wires, which tend to check the secondary and primary electrons respectively. The fact that the peculiar form of the curves obtained was due to secondary electrons from the anode was clearly proved by experiments with the secondary anode; the alterations of the characteristic curves when different voltages were applied to this anode could only be explained on the assumption of secondary emission. Other points in the theory are considered, including the deflection of the primary electrons by the charge on the grid wires, as they pass through the meshes; this may prevent the electrons from reaching the anode, even when their range in the electrostatic field between the grid and anode is long enough otherwise. The paper concludes with remarks as to the conditions to be observed in the construction of tubes for technical purposes. H. N. A.

1445. *The Kathode and Anode Potential Gradients in the Hg, Zn, Cd, and Mg Vacuum Arcs.* **H. Schüler.** (Zeits. f. Physik, 14. 1. pp. 32–43, 1923.)—The measurements, with vacuum arc lights, contained in the present paper have been made under experimental conditions as simple and as free from objection as could be devised, which latter are copiously described in the paper. With the Hg arc, the potential difference between 5 and 20 amperes is independent of the current strength and amounts to 9·20 ± 0·15 volts. Fe, Ni, and Pt anodes give the same values within experimental error. The Stark measurements for very small current strengths gave 8·16 volts. Since the kathode gradient in the region of 2 to 50 amperes is, according to Stark, independent of the current, there are two especially pronounced values for the anodic gradient. With the Zn arc measured with a strongly heated kathode (a kathode with a liquid surface analogous to mercury), the gradient for small current strengths is 8·80 ± 0·15 volts and for large ones 10·53 ± 0·15 volts, being independent of current strength within 10–30 amperes. With weak currents (1 to 3 amperes) Stark's observation of a linear rise for Hg is confirmed,

but with stronger currents the voltage approaches a constant value. For the Cd arc, measured between 10–20 amperes under the same conditions as for Zn, the value is 9·9 ± 0·15 volts. With the Mg arc and a highly heated kathode, 12·30 volts were found at 10 amperes and 12·45 volts for 30 amperes. An explanation of these values is attempted on the lines indicated by Franck [see Phys. Zeits. 22. 443, 1921].
H. H. Ho.

1446. *Diffraction of Hertzian Waves.* **N. Kapzov.** (Ann. d. Physik, 69. 2. pp. 112–124, Nov. 2, 1922.)—Hertzian waves of λ about 3 cm. give, in a lattice consisting of resonators, diffraction figures analogous to the diffraction of X-rays in the Briggs experiments on crystals. The Briggs-Wolf formula $\nu\lambda = 2d \,.\, \sin \vartheta$ is equally applicable. A lattice, the natural period of whose elements is very nearly the same as the resonance-period of the Hertzian waves, absorbs and scatters these waves powerfully.
A. D.

1447. *Undamped Oscillations in Electrostatically Coupled Circuits.* **W. W. Tartarinow.** (Archiv f. Elektrot. 12. pp. 16–25, March 10, 1923.)—The treatment is mathematical, and deals with two circuits with a common condenser, each having another condenser and an inductance, but the first having negative resistance. The differential equations are shown to be exactly similar to those of an electrically driven mechanical model of masses and springs, which is described. Solutions of the equations are obtained for frequency and amplitude of the resulting oscillations under various conditions of coupling and circuit constants, and for the phase-differences and energy distribution.
E. M.

1448. *Propagation of Electromagnetic Waves along Two Parallel Wires.* **G. Laville.** (Comptes Rendus, 176. pp. 573–576, Feb. 26, 1923.)—The author shows that the theories of Kirchhoff and Kelvin explain the phenomenon of propagation of electromagnetic waves along parallel wires, with an accuracy equally great to that obtained from the more complicated theories of Sommerfeld and Mie. [Abstracts 570 (1899) and 2027 (1900).]
A. B. W.

1449. *Rotary Polarisation of Long Waves.* **K. F. Lindman.** (Ann. d. Physik, 69. 4. pp. 270–284, Nov. 16, 1922.)—Following up a previous paper [Abstract 518 (1921)] the author finds Natanson's formula for the angle of rotation quantitatively confirmed within the errors of experiment.
A. D.

1450. *Bending of Undamped Electrical Waves by Dielectric Cylinders, and the Electrical Vibrations of such Cylinders.* **C. Schaefer** and **J. Merzkirch.** (Zeits. f. Physik, 13. 3. pp. 166–194, 1923.)—Schaefer and Grossmann attacked the above problem in 1910 [Abstract 720 (1910)], but failed to find the effects of the natural electrical vibrations of the cylinders. The present paper starts with an account of the mathematical theory, and describes experiments with undamped electrical vibrations produced by Barkhausen and Kurz's method with a Schott electron tube. The previous failure was due to the fact that the electrical vibrations employed were strongly damped. The present measurements show a most satisfactory agreement with the theory, the observed values of the electrical vector falling very close indeed to the theoretical curve when the radius of the cylinder is gradually altered, and the distribution of energy round the cylinder agreeing very closely with the theoretical value in the numerous cases investigated; these included one in which the electrical vector was perpendicular to the axis of the cylinder; two natural vibrations of the cylinder were observed in this case, and four when the vector was parallel to the axis. The cylinders consisted of thin glass tubes, of varying diameter, filled with water; a length of 1·5 metre was found to be sufficient, though in the theory they were supposed to be infinitely long. Interesting observations were made on the working of the Schott tubes; it was found possible, with certain tubes, to obtain very short wave-lengths under certain conditions, which appeared to depend on resonance phenomena in the tube. Contrary to the usually accepted idea it was found that vibrations can take place in tubes that are not constructed symmetrically, the fineness of the wires of the grid being much more important than perfect symmetry. H. N. A.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1451. *Metallic Conduction Electrons.* **L. A. Welo.** (J. de Physique et le Radium, 4. pp. 71–76, Feb., 1923.)—Parson's annular magnetic electron has not been found by Compton to exist; recension of Compton's method, found not conclusive; but the author has failed to find evidence for the annular electron. A. D.

1452. *Ohm's Law.* **W. Kummer.** (Schweiz. Elektrot. Verein, Bull. 14. pp. 177–179, March, 1923.)—J. Fischer-Hinnen had treated Ohm's law as a particular case under force-flux; A. Imhof had challenged this; the author supports Fischer-Hinnen. A. D.

1453. *Electrical Properties of a Heavy Glass.* **G. L. Addenbrooke.** (Phil. Mag. 45. pp. 516–525, March, 1923.)—A dense silica flint glass, SiO_2 22, PbO 78 per cent.; refr. ind. for D line 1·9201, medium dispersion C–F 0·04381, sp. gr. 6·01; dielectric constant, 13 within 2 to 3 per cent. Observations on curves showing results for a series of glasses. Discussion of methods of obtaining dielectric constants of substances in mixture. A. D.

1454. *Electromagnetic Motions in Electric Furnaces.* **C. Hering.** (Am. Electrochem. Soc., Trans. 41. pp. 303–310, 1922.)—The subject is supplementary to that of a paper read a year ago. It is described how a new proposed law given in the former paper may be applied to the production, by the current, of certain desired motions such as those for circulating or stirring liquid conductors in a furnace. Guides are given to aid one in determining whether such motions can probably be produced by the current. It is maintained that the former restrictions to only one such motion-producing force were not justified, and that many others formerly not accepted are possible. AUTHOR.

1455. *Electromagnetic Forces and a Proposed Revision of the Laws.* **C. Hering.** (Am. I.E.E., J. 42. pp. 139–154, Feb., 1923.)—Reasons are given why it is desirable to revise some of our older laws regarding electromagnetic forces and motions which are the basis of all electromotive devices, in order to conform better to more modern developments. Researches with high current-densities in such mobile conductors as liquids and arcs have brought out some heretofore unnoticed forces, the existence of some of which has been denied. Some of our older laws are claimed to mislead, to be inaccurate, incomplete, to involve unnecessary complications, are based on the wrong fundamentals, specify results contrary to the facts, and are not universal, thereby checking possible progress if accepted as universal. The following general law is proposed: In an electromagnetic system in which the current is being maintained by a source, any and only such mechanical motions of the conductor will tend to take place as will generate a counter e.m.f. somewhere in the circuit. It is shown that this law leads to the existence of a force longitudinal to the conductor. Numerous experiments are described to bear out the arguments. W. R. C.

1456. *Forward and Back Electromotive Forces: Negative Winding Numbers.* **F. Emde.** (Elek. u Maschinenbau, 41. pp. 165–172, March 18, 1923.)—The author calls attention to the difficulties which all have felt in the use and interpretation of plus and minus signs in electrical work. At one time, in continuous-current work, a back e.m.f. due to resistance was invoked, while with alternating currents the question of signs is apt to be very confusing. The whole question is carefully treated, and the paper should be helpful. The proposal to place a positive sign before the number of turns of a right-handed spiral, and a negative sign in the case of a left-handed one, is rejected, as it is the direction of circulation of the current, and not the way the wire is wound, which is of importance. H. N. A.

1457. *Electric Resistance of Ordinary Lead and of Uranium Lead below 14° K.* **H. K. Onnes** and **W. Tuyn.** (K. Akad. Amsterdam, Proc. 25. 9 and 10. pp. 451–457, 1923. Comm. No. 160B from the Phys. Lab. Leiden. In English.)—The object of the present investigation has been to establish the vanishing-point temperature of lead more accurately, as well as to trace the difference in the vanishing-point temperature of lead and uranium lead (RaG) and to follow the course of the change in the resistance of lead with the temperature above the vanishing-point. Regarding a possible difference of vanishing-point temperature for isotopes, it appeared not impossible that the occurrence of the superconductivity might be influenced by the mass of the nucleus [see Abstract 57 (1919)]. Section I gives the method of preparing the resistances; Section II shows the arrangement of the crystal; Section III contains resistance and temperature determinations; Section IV gives the temperature of the vanishing-point, *viz.* 7°·2K. In Section V a comparison is made of the vanishing-point temperatures of lead and uranium lead (RaG), but it is found that Kahlbaum lead (at. wt. 207·2) and uranium lead (RaG), at. wt. 206·06, have the same vanishing-point temperature within the accuracy of 1/40 degree. Section VI considers resistances above the temperature of the vanishing-point, and data curve being included. H. H. Ho.

1458. *Electric Resistance of Thallium in the Temperature Field of Liquid Helium.* **H. K. Onnes** and **W. Tuyn.** (K. Akad. Amsterdam, Proc. 25. 9 and 10. pp. 443–450, 1923. Comm. No. 160A from the Phys.

Lab. Leiden. In English.)—The place of thallium in the periodic system of elements between the super-conducting metals mercury and lead, made it seem probable that it would become super-conducting at helium temperatures. This probability has now received experimental confirmation. The method of preparing the resistances first receives very full attention. Section II gives the zero determinations. Section III contains the measurements in liquid helium and the determination of the vanishing point temperature, *viz.* 2°·32K. Section IV gives the highest limit of a microresidual resistance, and Section V the threshold value of the current, *i.e.* the strength of the current sent through the wire which again generates a measurable potential difference. The paper is replete with data. H. H. Ho.

1459. *Measurement of Small Resistances.* **W. Esmarch.** (Ann. d. Physik, 69. 4. pp. 255–269, Nov. 30, 1922.)—Very exact results obtained by a modification of Benedicke's bridge. A. D.

1460. *Dielectric Constants of Certain Aqueous Solutions, and their Explanation by Means of Debye's Dipole Theory.* **R. Fuerth.** (Ann. d. Physik, 70. 1. pp. 63–80, Jan. 18, 1923.)—Drude's method was employed in the measurements; the wave-length remained nearly constant during all the experiments, being about 76 cm. in air. The apparatus was calibrated by taking readings with the condenser filled with liquids of known dielectric constant before and after a series of measurements. Curves were obtained showing the relation between the percentage of dissolved substance and the dielectric constant for dextrose, levulose, cane suger, urea, glycocol, saccharine, gelatine, and albumin, and where possible for these substances in the solid state; some of these curves showed a rise in dielectric constant when the concentration was increased, some a drop, and in the case of saccharine there was a rise to a maximum followed by a drop. The author explains this by means of Debye's theory of dielectrics. Where an alternating field is employed, as in the present case, the theory must be modified, since the field tends to cause the dipoles to swing to and fro with a definite frequency, this being interfered with by inner friction and thermal movements of the molecules. Debye has worked out the effect of varying frequency on the dielectric constant; but it is not necessary to consider this in the present case, since the frequency is constant, and only the concentration is varied. From the qualitative point of view the following conclusions can be drawn: If the dipole moment of the dissolved substance per unit weight is greater than that of the solvent, increase of concentration will at first raise the d.c. of the solution; but the viscosity in general increases with the concentration, and at an increased rate as the concentration increases; the rate of increase of the d.c. will therefore diminish to zero, and the curve will rise to a maximum and then fall. In other cases the effect of increased viscosity will be greater than the effect due to the greater moment of the dipole of the solute throughout, and the curve will droop from the commencement, the rate increasing with the concentration; in other cases the curve rises throughout. If the moment of the solute is smaller than that of the solvent the curve falls from the commencement. When the viscosity or "toughness" becomes very great, as in the case of albumin and gelatine, the theory shows that the d.c. tends towards a limit, which is the d.c. for slow electrical vibrations. It is not possible to calculate the d.c. of a solution from the d.c. of the constituents. The theory is also discussed for the case of solutions of electrolytes. H. N. A.

1461. *Continuously Variable Rheostat with Constant Contacts.* **P. Kirkpatrick.** (Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 195–196, Feb., 1923.)—This rheostat allows a perfectly continuous resistance variation, the action depending on the alteration of the length of the resistor (mercury) by extending it in the middle, the end conditions being unchanged. A vertical tubular mercury well contains a glass tube of slightly smaller diameter which is raised or lowered by a counter-balanced cord. A metal rod whose upper end, fixed some height above the well and forming one of the rheostat terminals, enters the glass tube and dips to a small distance in the mercury. The other terminal consists of a wire dipping into the well at one side. The length of the mercury path is varied by raising or lowering the glass tube. T. C. H.

1462. *Null Methods of Measurement of Power Factor and Effective Resistance by the Quadrant Electrometer.* **D. Owen.** (Phys. Soc., Proc. 35. pp. 140–148 ; Disc., 148–150, April, 1923.)—The paper proposes null methods of using a quadrant electrometer to enable measurements of power factor and effective resistance in a.c. circuits to be made. Such measurements have hitherto been almost exclusively made by deflectional use of the electrometer ; it is then necessary to calibrate the instrument and to take account of the influence of electric control on the needle. If the voltages on needle and quadrants are arranged so that the deflection is reduced to zero, the instrument need not be calibrated, and the electric control has no effect. Such a null use of the electrometer possesses marked advantages due to simplification of theory, to the fact that steadiness of voltage is not so essential as in deflectional use, and to the usual general merits of null methods.

Two methods of connection of the instrument to attain the desired object are described. The theory is worked out and practical tests are recorded. It is also shown how the methods can be adapted for use at high voltages. The theory of the electrometer is worked out with a view to investigation of the effect of electric control and to emphasise the advantages of the null use of the instrument. In the *discussion*, various speakers brought out practical points arising in the use of the methods. **E. H. Rayner** drew attention to important details in the design of electrometers ; **A. Rosen** pointed out the need for great constancy of frequency in tests of condenser power factor. B. H.

ALTERNATING CURRENTS AND MAGNETISM.

1463. *Derivations and Perturbing Waves.* **C. Breitfeld.** (Schweiz' Elektrot. Verein, Bull. 14. pp. 83–93, Feb., and pp. 156–165, March, 1923.)—The author, adopting the ideas of K. W. Wagner, develops the theory of perturbing waves produced at the moment of putting into circuit a continuous-current line, having regard to the derivations (corona effect) due to imperfect insulation. Various examples are worked out, with diagrams. A. D.

1464. *Hypothesis of the Elementary Demagnetising Field and of the Molecular Field.* **P. Dejean.** (Comptes Rendus, 176. pp. 388–391, Feb. 5, 1923).—From expressions for the actual and apparent intensities of magnetisation of a paramagnetic body, the equation found for the total field and that for the molecular field are shown to be similar in construction. It is considered, from this, that the two hypotheses are closely related. [**Errata,** *ibid.* p. 542, Feb. 19, 1923.] G. E. A.

1465. *A Levitated Magnet.* **F. H. Glew.** (Nature, 111. p. 669, May 19, 1923.)—Using a cobalt-chrome steel bar placed in a glass cell over the poles of a good horse-shoe magnet, the author has succeeded in keeping the bar poised in air at a height of about ½ inch above the magnet. The bar was 2½ inches long and contained 15 per cent. cobalt. G. E. A.

1466. *Distribution of a Natural Element.* **B. Weinberg.** (Terrest. Magn. 27. pp. 137–155, Dec., 1922.)—If any natural element, that varies continuously both in space and time (such as air pressure or magnetic force), be measured, the problem is to obtain the distribution of such an element on the surface of the globe from a few measurements. The problem is first considered with regard to time and then with regard to space. With regard to time, an application of the probability law gives the most satisfactory method of "smoothing." With regard to space distribution the problem of drawing isolines on a map is considered in detail. The usual assumptions (*e.g.* that the element varies in proportion to its distance from a station; that if the element has equal values at adjacent stations it has the same value on the joining line) are shown to be generally incorrect. *Magnetic Surveys.*—These points are illustrated by reference to the magnetic survey of part of Siberia. Different methods of drawing isolines lead to very different results, and point to the necessity of a general agreement among scientists concerned. The author employed parabolic curves, finding the constants by the method of least squares, several sets being obtained successively and smoothed. This method is claimed to give much closer agreement with "real" lines (obtained by other ways) than the methods in general use. Finally suggestions are made, in view of the importance of increasing the number of stations, so as to reduce the programme of magnetic measurements in inaccessible areas, such as Siberia. It is contended that increase in number of observations is of far greater importance than the loss of accuracy entailed. He suggests that methods of determination should be simplified and less complex types of instruments used.

J. A. Fleming (Terrest. Magn. 27. pp. 156–168, Dec., 1922), commenting on the above, contends that multiplicity of relatively inaccurate observations would be a mistake, and points out that experience shows that modern magnetometers can be transported; and that it is now possible to secure with a universal instrument good observations for the determination of all three elements in a very short time. W. A. R.

1467. *Generation of Suitable Voltages and Currents for Deep Therapy—American Practice.* **C. H. Holbeach.** (Inst. El. Eng., J. 61. pp. 369–376, March, 1923.)—In the past few years considerable strides have been made in the improvement and simplification of X-ray equipments both for medical and industrial purposes. X-ray workers are, however, wholly always in advance of the apparatus at their disposal; hence standardisation is difficult. The call for highly penetrative X-radiations of shorter wave-length, involving the maintenance of 200,000 volts at the tube terminals for continuous running, has imposed many difficult problems on the designer and manufacturer. These difficulties have to a great extent been solved by research laboratories in America, and the present paper deals with American methods under the following heads: Fundamental principles of design; high-voltage tubes; rectification; general design of apparatus; future developments. A summary of the already published research work would indicate that (1) The oil-immersed a.c. transformer, in conjunction with a mechanical rectifier and the constant-potential machine, is the most efficient means of generating high voltages for continuous working. (2) The present-day form of mechanical cross-arm type rectifier lends itself admirably, if suitably modified, to the rectification of higher potentials. (3) The ballasting action of resistance offers certain well-defined advantages over auto-transformer control when operated with a hot-kathode tube at high potentials. (4) A voltmeter connected across the primary of an a.c. transformer should be calibrated against a standard sphere gap. (5) The current in the secondary or tube circuit must be kept virtually constant in order to minimise the high-tension voltage fluctuations due to the resistance in the primary circuit. The following experimental data with regard to Coolidge tubes for deep therapy is also now available: (1) The 200,000-volt tubes have a substantially constant output. The filtered radiations through 2 mm. of copper varied only 1¼ per cent. over a series of 29 tubes, the terminal voltage being 200 kv. at 2 ma. (2) Where no filter is used for superficial skin therapy this constancy is lessened, owing to a slight variation in the thickness of the tube wall. (3) The effect of the tungsten deposit on the inner walls of badly abused tubes may be neglected in deep therapy. (4) The distribution of intensity around the girdle, and in a plane containing the tube axis and perpendicular to the target face, varies markedly and, therefore, the angle at which the tube is operated is a factor of sufficient importance to warrant close attention. A. E. G.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1468. *The Element Celtium.* **M. de Broglie** and **J. Cabrera.** (Comptes Rendus, 176. pp. 433–434, Feb. 12, 1923.)—Zirconium minerals containing celtium (at. no. 72) give with X-rays a discontinuity at $\lambda = 0\cdot1905$ Å., which also corresponds to atomic number = 72. A. D.

1469. *Nature of Graphite and Amorphous Carbon.* **G. Asahara.** (Japanese J. of Chem. 1. 2 and 3. pp. 35–41, 1922.)—X-ray examination is made of 34 samples of representative forms of carbon ranging from lustrous flaky Ceylon graphite to soots and charcoals. In agreement with the observations of Debye and Scherrer [see Abstract 1130 (1916)], the investigation supports the view that so-called amorphous carbon is essentially identical with graphite, *i.e.* the word "amorphous" must in this case be interpreted as designating "extremely minutely crystalline." A. B. C. L.

1470. *The Calculation of Atomic Weights.* **K. Fehrle.** (Zeits. f. Physik, 13. 4. pp. 264–267, 1923.)—If the differences be taken between the experimental atomic weights and those derived by the author (see Phys. Zeits. 21. p. 162, 1920) as ideal atomic weights, and these numbers be taken as ordinates with the atomic numbers as abscissæ, then the differences are seen to be a periodic function of the numerical order for 72 consecutive elements containing fundamental periods. This relationship has been found to hold mathematically for the purpose of representation by a Fourier series, and the author accordingly assumes that deviations from the ideal atomic weights are due to coupling with the ether. The curve above has therefore been analysed by means of a Fourier series, and the coefficients are found to be given by the expression $A_n = 2(72 - n)^3/10^6 p$, where n is the oscillation number of the respective harmonic vibration and p the largest common multiple between n and 72. The hardest problem, however, is to find a regular connection between the phase constants, this being worked out in the paper to the following expression, $O_n = 184\cdot50 - 90(m - n)(-1)^r$. where n is the oscillation number as above, m signifies in the intervals from 1 to 27, 37 to 45, and 55 to 72, the order number of the inert gas preceding the element in question, and in the intervals from 28 to 36 and 46 to 54, the order number from the immediately following inert gas; r is the number of the nearest inert gas when He is reckoned as 1. The experimental atomic weight of an element of order number t is then found to be:

$$M_t = \sum_{1}^{t} \sqrt{67\cdot7 + (t-1)\,.\,16\cdot59}$$

$$+ \sum_{n=1}^{n=72} \frac{2(72-n)^3}{10^6 p} \sin\left[\frac{2\pi nt}{72} + 1\cdot025\pi - \frac{\pi}{2}(m-n)(-1)^r + 0\cdot041\pi n)\right]$$

H. H. Ho.

1471. *Stability of Atom Nuclei; the Separation of Isotopes and the Whole Number Rule.* **W. D. Harkins.** (Frank. Inst., J. 194. pp. 165–211, Aug.; 329–356, Sept.; 521–535, Oct.; 645–681, Nov.; 783–814, Dec., 1922; 195. pp. 67–106, Jan., and pp. 553–573, April, 1923.)—The author deals at considerable length with the problem of atomic structure viewed mainly from the standpoint of the chemist. He considers that the chemical data which are of most value in the study of the nuclei of atoms are the accurately determined chemical or mean atomic weights. The avowed object of this series of papers is to show that the discovery of isotopes has made the mean atomic weights assume a place of much greater importance since they now become the basis of study of nuclear composition and stability. In the first paper the author elaborates what is called the whole number rule, *viz.* (1) the atomic weight of any pure atomic species is very close to a whole number on the basis of 16 as the atomic weight of oxygen (or of 12 as the atomic weight of carbon, etc.); (2) the atomic weight may be expected to be even closer to a whole number when it is divisible by 4 than when it is not so divisible. Reference is also made to the discovery of isotopes predicted in earlier papers and to recent experimental work on the separation of isotopes by various methods (*e.g.* gaseous diffusion). Many photographs of α-ray tracks showing "forks" are reproduced, and their bearing on theories of atomic structure discussed.

The series of papers constitutes a review of recent work on atomic series, isotopes, etc., with particular reference to the author's own work on the subject. A concise abstract is not possible. A. B. W.

1472. *Propagation of Flame in Complex Gaseous Mixtures. V. Interpretation of the Law of Speeds.* **W. Payman.** (Chem. Soc., J. 123. pp. 412–420, March, 1923.)—The addition of incombustible nitrogen to mixtures of $(CH_4 + 2O_2)$ reduces the speed of the uniform movement of the flame. The addition of either methane or oxygen has a similar effect. The speed depends upon the rate of reaction in the mixture and hence mainly upon the temperature of the burning gases, and the greater cooling effect of an additional component should be accompanied by a greater retarding effect. Methane, having the highest specific heat of the three gases, has indeed the greatest retarding effect. If this were the only retarding factor, the law of speeds [Abstract 1652 (1922)] would be accounted for. If two different volumes of methane and of nitrogen had the same retarding effect, they should have the same heat capacity, and given proportions of the one of these gases should be able to replace the other; this is confirmed. Further, the law of speeds might, within limits, hold for other modes of flame propagation, *e.g.* for the detonation wave. This wave differs from the uniform movement because the addition of hydrogen to $(H + O)$ mixtures and of CH_4 to $(CH_4 + O)$ mixtures increases the value of detonation, whilst retarding the uniform movement. The speed law should hold for detonation in $(H + O + N)$ mixtures, provided the oxygen present suffices for complete combustion of the hydrogen. This was tested with Dixon's apparatus [see following Abstract]. The law of speeds does not hold exactly for all mixtures, however, on account of the effect of mass-action. The retarding effect of oxygen on the uniform movement is slightly smaller than that of nitrogen, although their specific heats are nearly equal, because the concentration and the number of fruitful collisions have to be considered. Experiments are made on maximum-speed mixtures and mixtures for complete combustion (limit mixtures), with pentane, methane, coal gas, and hydrogen. As was to be expected, the mass-action effect becomes less important when the oxygen percentage much exceeds that for complete combustion. The conclusion drawn is that the speed of uniform flame movement depends upon the rate of reaction between the inflammable gases and the oxygen in the flame front. The law of speeds would hold exactly if that rate were solely determined by the temperature; the influence of concentration tends on the whole to retard the movement in complex mixtures. H. B.

1473. *Rate of Detonation in Complex Gaseous Mixtures.* **W. Payman** and **N. S. Walls.** (Chem. Soc., J. 123. pp. 420–426, March, 1923.)—Detonation limits are difficult to observe. An addition of inflammable gas to the lower-limit mixture (l.l.m.) will increase the rate of detonation; with increasing addition to electrolytic gas, however, the rate will increase in the case of hydrogen, but decrease in the case of CO. There is no max.-rate detonation mixture, corresponding to the max.-speed mixture (m.s.m.) of uniform movement. The following are comparative figures, in which D stands for detonation, U for uniform movement, m. indicates speed in m. per second, per cent. refers to methane, and "up.l.m." means "upper limit mixture":

l.l.m.	D 11·1 p.c.	1678 m.	U	5·7 p.c.	0·199 m.
up.l.m.	,, 53·3 ,,	2388 ,,		59·2 ,,	0·189 ,,
m.s.m.	,, 50 ,,	2508 ,,		33·3 ,,	55 ,,

In the experiments mentioned in the preceding abstract, made with mixtures of (H+O+N), the detonation rate increased from 1600 to 3532 m. per sec. as the H per cent. rose from 21 to 89 (rest oxygen) and the rate did not much diminish as the oxygen was more and more replaced by nitrogen (up to 40 p.c.); that held also for (CH_4 + H + O) mixtures, but the actual figures should be studied. The law of speeds would, therefore, apply to these detonation waves, provided there be enough oxygen for the complete combustion of the inflammable gases to steam and CO_2. H. B.

1474. *Effect of Pressure on the Inflammability Limits of Paraffin Hydrocarbon-Air Mixtures.* **W. Payman** and **R. V. Wheeler.** (Chem. Soc., J. 123. pp. 426–434, March, 1923.)—According to Mason and Wheeler [Abstract 283 (1918)], increased initial pressure narrows the limits of inflammability of hydrogen and of CO in air on both sides, *i.e.* more inflammable gas is required to form a lower-limit mixture and more air for an upper-limit mixture; for methane this was found to hold only as regards the lower limit. From the law of mass-action, an increase of pressure might be expected to extend both the limits with all gases, and Terres and Plenz (J. Gasbeleuchtung, 57. pp. 990, 1001, 1016, 1025, 1914) have ascribed the observed narrowing of the limits to the fact tha the heat loss from a gas at high pressure increases with pressure, the loss being due to convection rather than to conduction. Methane then would behave exceptionally. The authors therefore experiment with other hydrocarbons, ethane, propane, butane, pentane, at pressures up to 5000 mm., mostly with downward flame propagation, by the method of Mason and Wheeler. In the case of methane the range of inflammability lies at 1 atmo., between 6·0 and 13·0 per cent. of methane, at 6 atmo. between 6·4 and 16 per cent. Increasing pressure seems to bring the flame-temperature (or possibly the lowest temperature at which the flame begins to propagate) to a constant value for all proportions of the various mixtures. That would not account for the narrowing of the lower limit, however. There is for every inflammable mixture a limiting pressure, below which the flame will not be propagated; the first effect of increasing the pressure seems to be a widening of the inflammability limits on both sides, followed at higher pressure by a narrowing of one or of both the limits. The Terres-Plenz argument for narrowing the limits would only apply for downward propagation. With upward propagation ignition by sparks, even of high intensity, did not lead to self-propagation, because large caps of flame formed. Experiments with horizontal propagation were more successful; the extension of the upper limit was found to be more marked with horizontal than with downward flame propagation, as it should be according to Terres. Experiments were also made at reduced pressure, the method being as before, to determine two pressures, differing by 10 mm., at the lower of which the propagation, complete at the higher pressure, was only partial. Below 90 and 180 mm. (lower or upper limits) even sparks from a 10-in. X-ray coil failed to ignite the mixtures. It is concluded that the narrowing of the limits for downward propagation with increased pressure is due to convection currents, which also widen the limits of other modes of propagation. H. B.

1475. *Dissociation of Molecular Hydrogen, from the Entropies of Diatomic and Monatomic Hydrogen.* **G. Edgar.** (Am. Chem. Soc., J. 45. pp. 673–676, March, 1923.)—Calculations made of the free energy of dissociation, the dissociation constant, and the degree of dissociation, of molecular hydrogen into atomic hydrogen, from the entropies of the substances and published data for the heat dissociation indicate that, in accordance with the conclusions of Duffendack [see Abstract 163 (1923)] and of Saha, hydrogen is much more highly dissociated at high temperatures than might be concluded from earlier calculations. A. B. C. L.

1476. *Theory of the Corrosion of Iron.* **J. N. Friend.** (Am. Electrochem. Soc., Trans. 40. pp. 63–75; Disc., 75–80, 1921.)—After discussing the known facts and theories, and the still unexplained phenomena of rusting, the author puts forward an auto-colloid catalytic theory, which postulates the corrosion as starting by the formation of colloidal ferrous hydroxide. This oxidises by contact with the air to hydrated ferric hydroxide sol, which latter is alternately reduced by contact with iron and oxidised by contact with air, thus continuing the corrosion; and, upon flocculation, it yields rust. [See also Abstract 573 (1923).] AUTHOR.

1477. *Adsorption of Silver Salts at Silver and Gold Surfaces.* **E. G. Rudberg** and **H. v. Euler.** (Zeits. f. Physik, 13. 5. pp. 275–283, 1923.)—Earlier work on adsorption deals essentially with a solid adsorption medium, with the ratio between the amount of adsorbed material and the volume concentration in the environment. Further progress is doubtless to be effected by a study of the chemical and electrical forces at the phase boundary and their comparison with other chemical and electrical processes. The object of the present investigation has been the exact measurement of concentration changes which take place in a dilute silver salt solution under the influence of silver and gold surfaces of known dimensions. Previous work by Euler with Hedelius and Zimmerlund is briefly discussed. Experimental arrangements are then described and tables of results given, the influence of surface condition, temperature, and solvent being included. The adsorption of other salts has been also investigated, *e.g.* Na_2SO_4, KCl, NH_4CNS, to see if different effects would be made manifest, inasmuch as the adsorption of silver salts is assumed to be conditioned by the formation of the Helmholtz-Nernst double layer. At the clean metallic surfaces no adsorption is found to occur, but if oxide layers be allowed to form then appreciable results are obtained. As soon as the oxide layer is removed, adsorption ceases. The paper concludes with a calculation of the average ionic diameter in the adsorption layer which for the silver surface is $1 \cdot 4 \times 10^{-8}$ cm. and at the gold surface is $1 \cdot 9 \times 10^{-8}$ cm. H. H. Ho.

1478. *A Direct Process for the Determination of Solubilities at High Pressures.* **E. Cohen, D. H. P. Voller, and A. L. T. Moesveld.** (Zeits. phys. Chem. 104. pp. 323–331, March, 1923.)—A determination of the influence of pressure on solubility is made in the case of thallium sulphate in water. The apparatus consists of a glass pipette mounted in compression bomb of steel in which the pressure can be maintained constant over a long period. The bomb is constructed in the form of a **U**-tube of 46 cm. height and with channels of an internal diameter of 2 cm., and is placed in a thermostat and given an oscillatory movement. The solubility vessel consists of two pipettes, one above the other, and connected by a narrow-bore tube provided with a bulb enlargement in which cotton is placed to serve as a filter. The lower pipette is filled with the solvent saturated with the salt at a higher temperature than that subsequently employed, the higher pipette is filled with benzene and a small amount of mercury placed at the base of the lower pipette and connected with a quantity of mercury in a basin. The upper pipette is connected by a rubber tube with the outlet at the top of one arm of the bomb. The bomb is then evacuated, completely filled with mercury, and the pressure applied by forcing in oil.

On attaining equilibrium after several hours' shaking in the thermostat, the outlet tube is opened together with the inlet in such a manner as to avoid fall of the pressure, and the benzene in the upper pipette is thus displaced from the bomb by the saturated solution which passes from the lower to the upper pipette and is filtered on the way by the cotton. The vessel is then opened and the contents of the upper pipette are analysed. The thallium sulphate used is prepared from electrolytic thallium and sulphuric acid. Measurements are made at a temperature of 30·0° C. and at pressures up to 1500 atmos. The increase in solubility of thallium sulphate with pressure is found to give values which agree closely with the relation: $C = 5 \cdot 831 + 0 \cdot 003377p - 0 \cdot 000\,000175p^2$ where C represents the solubility in grammes of salt per 100 g. of solution, and p the pressure in atmos. J. N. P.

1479. *Law of Solution.* **P. Mondain-Monval.** (Comptes Rendus, 176. pp. 301–304, Jan. 29, 1923.)—Measurements made with sodium nitrate, which dissolves to a great extent in water, give results in very good agreement with the formula given by le Chatelier in 1885 and by van't Hoff shortly afterwards, namely, $500L dT/T^2 + i dC/C = 0$.

T. H. P.

1480. *The Scattering of Light by Organosols and Gels of Cellulose Acetate.* **E. W. J. Mardles.** (Faraday Soc., Trans. 18. pp. 318–326, Feb., 1923.)—Measurements of the change with temperature of the Tyndall number for sols and gels of cellulose acetate in benzyl alcohol during the reversible sol to gel transition are now described with full experimental details. With fall in temperature of the sol the rate of change is small and regular until a certain critical temperature, termed the maximum gelatin temperature, is reached. After this point the rate of change increases with acceleration, but eventually there might be a point of inflection on the curve relating the Tyndall number and temperature. The position of this point of inflection depends on the rate of cooling, and is determined by the formation of a firm jelly structure which inhibits the development of opalescence. The Tyndall number for a gel is a function of the mechanical treatment as well as rate of gelation; it also varies with time, the rate of change rapidly diminishing in absence of mechanical treatment. A gel tends to increase its Tyndall number, and mechanical treatment may induce a development of opalescence. The Tyndall number-concentration curve contains a maximum which tends to disappear at higher temperatures; thus the size of the particles in a gel structure is a function of the concentration and the temperature at which it was formed. There is a detailed resemblance of the Tyndall number-concentration curve to Tammann's curve relating the number of crystallisation nuclei or rate of crystallisation with degree of supersaturation; similarly with the relation between the distance of particles and their resultant molecular attraction. H. H. Ho.

1481. *Metallurgical Applications of Physical Chemistry.* **C. H. Desch.** (Chem. Soc., J. 123. pp. 280–294, Feb., 1923.)—The present lecture deals with the inter-relations between physical chemistry and metallurgy, more particularly in the study of chemical equilibria, that is upon the balanced reactions which occur in the smelting of metals. An example of such reactions, in the roasting of sulphide ore, by heating in air is considered, and a further example in the case of the reduction of iron ore in the blast furnace is treated at some length. Eastman's equilibrium diagram for the blast-furnace reaction is discussed, and reference is made to the work carried out by the U.S. Bureau of Mines. The chemical reactions in the case of slags are dealt with, and applications are given of the distribution principle, of a substance between two solvents, to the case of the metallurgy of steel. An account is given of the lines along which the study of the crystalline structure of metals and alloys has proceeded, and microphotographic examples are included.

A. W. J.

1482. *Velocity of Catalytic Reactions.* **J. Salkind.** (Zeits. phys. Chem. 104. pp. 177–191, March, 1923.)—Experiments are made on the catalytic action of colloidal palladium or platinum sponge in the hydrogenation of some acetylene derivatives. In the production of the corresponding ethylene derivatives it is found that the value of k in the expression for a monomolecular change, $k = \frac{1}{t}\log\frac{a}{a-x}$, increases or decreases in different cases in a regular manner during the progress of the reaction. In the case of acetylene glycol derivatives with light radicals which have a strong affinity for hydrogen, a progressive increase of k with a palladium catalyst is obtained in close accordance with an expression of the form $k_1(1+\epsilon) = \frac{1}{t}\log\frac{A+\epsilon x}{A-x}$. It is found that the increase in the rate of hydrogenation cannot be attributed to a direct influence of the beginning or end reacting materials, but is due to an autocatalytic action of intermediate products. In the hydrogenation of less reactive acetylene derivatives, such as glycols with heavy radicals, inhibiting factors predominate, probably due to loss of activity of the catalyst, and the value of k falls during the reaction. The nature of the reaction is also determined by the amount of catalyst. With some glycols, a large amount of palladium cause an increase of k with time and with small amounts an initial increase is obtained followed by a fall. With a platinum catalyst a different type of reaction is given whereby four atoms of hydrogen are absorbed in place of two, and derivatives of the methane series obtained. These reactions, in most cases, follow closely the first order relation. In fermentative processes, such as the inversion of cane sugar in presence of invertin, a reaction of the first order is obtained for low concentrations of sugar, while at higher concentrations the rate of reaction is constant for a given amount of invertin and independent of the amount of sugar. This relation is characteristic of catalytic processes generally where intermediate reactions take place with the catalyst with comparatively low velocities. J. N. P.

1483. *Simple Form of Apparatus for Observing the Rate of Reaction between Gases and Liquids, and its Use in Determining the Rate of Solution of Oxygen by Water under Different Conditions of Mixing.* **H. G. Becker.** (Phil. Mag. 45. pp. 581–592, March, 1923.)—The paper is devoted mainly to the description of the apparatus employed (for which the original should be consulted), its calibration and use. The principle utilised, which depends on the pressure changes occurring when a liquid is placed in contact with a closed volume of a gas that it is capable of absorbing, has been employed in previous similar work [see Abstracts 647 (1920) and 1208 (1922)]. The results obtained with oxygen and water, with varying surfaces of absorption produced by varying rates of rotary stirring, are given in tables and graphs and discussed. Conditions are indicated under which the rate of solution is liable to sudden and unaccountable variations within narrow limits. A. B. C. L.

1484. *Dissociation-Equilibria by the Method of Partitions.* **R. H. Fowler.** (Phil. Mag. 45. pp. 1–33, Jan., 1923.)—Preceding papers [see Abstracts 713 and 714 (1923)] dealt only with assemblies in which the various systems retain an individual existence throughout, dissociation being specifically excluded. The method is here extended to cover dissociation, and remains simple and satisfactory, and leads, the author believes, to extensions of known results. Darwin and he agree with Ehrenfest and Trkal [Abstract 1576 (1921)] that the study of chemical constants, thermodynamic probability and absolute entropy can be logically approached only by statistical study of dissociation-equilibria. The latter, however, assume that all degrees of freedom are "fully excited," so that classical dynamics apply, or "completely unexcited," when they may be ignored. This restriction is here removed, and the remaining restrictions are no longer mathematical, but apparently physical and inherent in the problem. The dissociation problem is introduced in its simplest form, $X_2 \rightleftarrows 2X$, which brings out the salient features of the method and the possible extensions of previous results. Ehrenfest and Trkal point out that it is not really allowable to treat the internal vibrations of the diatomic molecule along its axis of symmetry as completely unexcited. This degree of freedom must be allowed its proper share of energy, which may be appreciable if there is appreciable dissociation. The kinetic energy of translation of atoms and molecules must be included, and the rotations of the latter about any transverse axis. By including such quantised motions, the results of these authors are extended and completed. Axial rotations of the molecules and all rotations of the atoms can be ignored as completely unexcited. There is no difficulty in formally including them if required. The new feature is the appearance of the partition function B(T) for the rotational and vibrational energy of the molecules. These cannot strictly be separated, but the band spectra show that these motions are approximately independent and the separation can be made, and it shows also that in general the vibration terms greatly exceed the rotation terms. The latter can then be regarded as fully excited, the former as practically unexcited. The reaction isobar then takes successively a series of approximate forms, given and discussed. A complete constant factor of these equations plays a part necessarily equivalent to that of the chemical constants of the atoms and molecules. Moreover, the factor B(T) occurring in the presumably quite general equation (4·12) giving the dissociation-equilibrium, "the reaction-isobar" should be largely determinable from the band spectrum. Could this be completely analysed at any one temperature, all possible rotational and vibrational states of the molecule would be determined, and it would remain only to attach precise values to the weights to completely specify B(T). These results are applied to Saha's ionisation theory of stellar atmospheres [Abstract 384 (1921)]. The author's conclusion is that a further term should be included, possibly making Saha's formula less definite. Extension follows to the general dissociation problem. The same method is applied to the general vapour-pressure equation, leading to general formulæ for the chemical constants, which show their dependence on the weights of the lowest permitted quantum states of the molecules. The chemical constant of H_2 when behaving like a monatomic gas is discussed, adding important evidence as to the weights assignable to the first two quantum states of the rotational motion. The absence of the state of no rotation demanded by the band spectra and by the curve of its own specific heats is confirmed. Finally, the constants in the dissociation equations are expressed in terms of the chemical constants introduced into the vapour-pressure equations.

G. W. DE T.

1485. *Equilibrium between Different Stages of Oxidation of Manganese.* **G. Grube** and **K. Huberich.** (Zeits. Elektrochem. 29. pp. 8–17, Jan. 1, 1923.)—Electrometric measurements were made of the equilibria existing between the mono-, di-, tri- and tetra-valent forms of manganese in sulphuric acid solution. The measurements of the oxidation potential were made by means of a compensation method, employing a normal electrode in combination with the manganese solution, thus: Hg | HgCl in NKCl | saturated KCl | Manganese solution | Pt. The results showed that, in a solution containing 0·05 gramme atom of manganese as manganese sulphate in 15N H_2SO_4, the potential $E_0Mn^{II} \longrightarrow Mn^{III} = 1{\cdot}511$ volt, the potential $E_0Mn^{III} \longrightarrow Mn^{IV} = 1{\cdot}642$ volt, and the potential $E_0Mn^{II} \longrightarrow Mn^{IV} = +\,1{\cdot}577$ volt. The potentials are dependent to some extent upon the total manganese concentration, and very largely upon the concentration of the acid. By means of the potential measurements the equilibrium constant of the reaction $Mn_2(SO_4)_0 \rightleftarrows MnSO_4 + Mn(SO_4)_2$ was calculated. F. J. B.

1486. *Determination of the Isoelectric Point of Gelatin. A Criticism of Patten and Kellems's Method.* **T. S. Price.** (Chem. Soc., J. 123. pp. 410–412, March, 1923.)—It has been found by Patten and Kellems that commercial and ashless gelatin apparently have different isoelectric points. This conclusion was derived from measurements in which *p*H values were measured electrometrically of a gelatin solution when added to water with varying concentrations of acid and alkali. On plotting *p*H values of the mixture against those of the water added, horizontal portions of the curves were obtained in different parallel positions whereby commercial gelatin appears to have an isoelectric point of *p*H = 5·64 compared with a value of 4·8 for ashless gelatin. It is pointed out in the present paper that the nature of the curves is due to the method of plotting, in which both axes are on a logarithmic scale, and that all that the method shows is that it requires more acid to give a definite *p*H value to the commercial than to the ashless gelatin, a result which is obvious in view of the known alkali content of the former gelatin. [See Abstract 768 (1923).] J. N. P.

1487. *The Decomposition of Explosives.* **O. Poppenberg.** (Zeits. angew. Chem. 36. pp. 80–85, Feb. 7, 1923.)—The gases primarily evolved during the ignition of explosive nitro bodies vary with the surrounding pressure which, when confined in an enclosed space, is a function of the density of loading. At low pressures oxides of nitrogen are, for instance, liberated, as is observed with unconsumed propellant burning at the muzzle of a gun. Further changes are also brought about in the gaseous composition during the subsequent cooling. The principal of these adjustments is due to the displacement of the water-gas equilibrium with falling temperature, while other reactions are the formation of methane and ammonia, the decomposition of acetylene and hydrocyanic acid formed at the high temperature and the reaction $2\ CO \longrightarrow CO_2 + C$. Wide and somewhat arbitrary variations are thus obtained in calorimetric determinations when conducted under different conditions.

In the case of detonations, the gases primarily produced are, on the other hand, independent of the nature of the enclosure and the density of loading, as the velocity of detonation is so high that air offers by its inertia a resistance similar to that of a metal. With detonations, however, unless immediate cooling of the products can be arranged, secondary reactions can occur as with explosions. A system of rapid cooling was applied to determine the composition of gases primarily resulting from the decomposition of explosives. The compound was supported in a metal enclosure suspended in a large evacuated bomb. The inner vessel was shattered by the explosion and the energy thereby absorbed caused a sufficiently rapid cooling of the gases to prevent displacement of the gas equilibria. An alternative method consisted in surrounding the explosive in the bomb with a vessel containing water or mercury.

By considering the different gaseous interactions which occur, formulæ are developed to enable the evaluation of the five variables C, CO, CO_2, H_2, and H_2O, when given the ultimate amounts of C, H, O, and N, the pressure as deduced from the density of loading, and the equilibrium values of the water-gas reaction and that of the reaction $2\,CO \rightleftharpoons CO_2 + C$ which, by means of the Nernst formula, are deduced from the temperature. An allowance is made for the small amounts of CH_4, HCN, and NH_3 obtained. In the case of a number of nitro bodies measured the calculated values of gas compositions agreed closely with those found experimentally. A similar agreement was also found in measurements of the amount of free carbon liberated at different densities of loading. The value of $(CO)^2/CO_2$ was found to diminish with increasing density of loading, and the separation of free carbon is first noticeable when this term has a value below 70, which with nitrocellulose occurs at a density of loading of 1·0 grm. per c.c. The value of this term for picric acid, at a density of loading of 1·0, is found to be 7·5. Similar measurements were made during detonation by using a fulminate initiator. J. N. P.

1488. *Action of Gelatin on Concentration Cells.* **R. Audubert.** (Comptes Rendus, 176. pp. 838–840, March 19, 1923.)—Where gelatin is added to concentration cells, consisting of $AgNO_3$ on the one hand, and of AgI, AgCl, or Ag_2S on the other, the e.m.f. ϵ of the cell is diminished if the addition be made to the $AgNO_3$, in which the concentration of $Ag^{\cdot}$ is C, but increased if the gelatin be added to the other silver salt of very low $Ag^{\cdot}$ concentration c. The addition of gelatin seems to diminish the C, and hence the ϵ, which depends upon the ratio C/c (Nernst). Assuming that a certain portion C_1 of the $Ag^{\cdot}$ ions would be adsorbed by the gelatin, the author studied the phenomena by varying the concentration of the $AgNO_3$ between N/10 and N/10,000, and the gelatin concentration between 1 and 0·04 per cent. The ϵ shows that the proportion C_1 of freed ions conforms to $C - C_1 = AC^p$, where p is approximately equal 0·5, as it is in Freundlich's formula for the adsorption isothermal of colloids. Hence it is concluded that the gelatin forms an adsorption complex with the silver ion. The value $p = 1/2$ also agrees with the author's experiments on the adsorption of the ions of La, Al, Ba, K, H by mastic and gamboge (Ann. de Phys., Sept., 1922); Perrin had suggested that the protective action of certain colloids on unstable colloidal solutions is of the nature of an adsorption. Further, Isgarischew and Berkmann [Abs. 1815 and 1820 (1922)] had shown that the overvoltage of the $H^{\cdot}$ ion passes through a maximum with the concentration of the gelatin added, which likewise suggests adsorption. That the addition of gelatin to electrolytic baths renders the grain of the deposited metal finer would be due to increased kathodic polarisation. H. B.

1489. *Theory of Electric Endosmose and of Ionic Double Layers, from Experiments with Charcoal Filters.* **Michaelis.** (Zeits. Elektrochem.

28. pp. 453–455, Nov. 1, 1922. Paper read at Deut. Bunsen Gesell., Leipzig, Sept., 1922.)—From the author's earlier work, carried out in conjunction with Rona, it may be assumed that charcoal is able to adsorb ions of all kinds, but in specifically different amounts. Of the ordinary inorganic cations the hydrogen ion is the most strongly adsorbed, and of the ordinary anions the hydroxyl ion, so that charcoal becomes charged positively in strong acids and negatively in strong alkalies. Thiosalicylic acid has now been investigated and is found to be more strongly adsorbed than the strong acids previously examined. If the author's theory is correct, this phenomenon must depend on the fact that the anion of this acid is adsorbed more strongly than the hydrogen ion. That this is actually the case is shown by the observation that, in solutions of thiosalicylic acid, charcoal assumes a negative charge, which cannot be annulled by any increase in the concentration of the acid.

According to the author's nomenclature, sugar charcoal or retort charcoal is termed an acidoid, *i.e.* a substance insoluble in water but showing, apart from its insolubility, all the characters of an acid. Blood charcoal, on the other hand, exhibits the properties of an ampholyte, *i.e.* it possesses for any definite hydrogen ion concentration of finite magnitude an isoelectric point; it is hence termed an ampholytoid. Previous experiments made by the author with Lachs and with Rona show that blood charcoal behaves as a mixture of two different adsorbents, one for surface-active non-electrolytes and the other for ions. Very few other powders show traces of such a property, powders which are good adsorbents, like kaolin, ferric oxide, alumina, etc., having no adsorbent effect on surface-active non-electrolytes. Towards the latter, it is now found that charcoals of all types behave similarly, whereas the two types of charcoal act quite differently as regards adsorption of ions. Blood charcoal, as an ampholytoid, fixes anions and cations, whilst sugar charcoal, as an acidoid, fixes only cations. T. H. P.

1490. *Dissociation of Strong Electrolytes in very Dilute Solutions.* **P. Gross** and **O. Redlich.** (Zeits. Phys. Chem. 104. pp. 315–322, March, 1923.)—A criticism is made of the conclusions of Washburn [Abstract 433 (1918)], who determined the values of the dissociation constants as evaluated from the expression

$$K_E = \frac{\alpha^2 c}{1-\alpha} = \frac{\Lambda^2 c}{\Lambda_\infty(\Lambda_\infty - \Lambda)}$$

in the case of potassium chloride. The value of K_E falls with the dilution, but is considered to reach a limiting value of 0·020 at a dilution of 2×10^{-5}N. Washburn also considered that in sufficiently dilute solutions all univalent salts of strong acids and bases obey the mass-action law and all have the same ionisation constant. It is contended in the present paper that the application of the law of mass action at limiting concentrations has been established theoretically but not experimentally in the measurements of Washburn, since lim. $dK/dc = 0$ only where $c = 0$ and actual measurements have not yet been made over a range of dilutions which give a constant value for K. In the light of formulæ which have been derived to show the influence of concentration on the value of K, it is shown by mathematical treatment that the limiting value cannot be established by means of measurements at any finite concentration. It is considered that the large increase of K with concentration is due to the influence of electric forces which first become marked at higher concentrations. J. N. P.

1491. *Electrolytic Dissociation of Cyanamide and some of its Salts in Aqueous Solutions.* **N. Kameyama.** (Am. Electrochem. Soc., Trans. 40. pp. 131–138, 1921.)—Sodium acid cyanamide in aqueous solutions is hydrolysed (at 25° C.) to the extent of 4·5–12·9 per cent. in the dilutions of 10–80 lit./g. mol., respectively. The primary dissociation constant of cyanamide, as an acid, at 25° C. was found to be $5 \cdot 42 . 10^{-11}$; the values at other temperatures were calculated from the heat of dissociation. The conductivity of the cyanamide has been found to be 54·4 at 25° C., a value nearly equal to that of the formate anion, which, according to Bredig, is 54·8. W. R. C.

1492. *Electrolytic Oxidation of Hydrochloric Acid to Perchloric Acid.* **H. M. Goodwin** and **C. Walker.** (Am. Electrochem. Soc., Trans. 40. pp. 157–166; Disc., 166, 1921.)—An investigation of the best conditions under which hydrochloric acid may be electrolytically oxidised to perchloric acid. Data are given showing the effect of concentration of acid, current density, duration of electrolysis, and temperature on the yield of perchloric acid. A cell is then described in which the process has been carried out successfully on a scale to yield 800 grammes of 60 per cent. acid per day of twenty-four hours. AUTHORS.

1493. *Electrolytic Oxidation of the Leuco-Base of Malachite Green.* **A. Lowy** and **E. H. Haux.** (Am. Electrochem. Soc., Trans. 40. pp. 123–128; Disc., 129–130, 1921.)—The tabulation of forty-four experiments, on the electrolytic oxidation of the leuco-base, is given. The conclusions arrived at indicate the necessity of a catalyst, an elevated temperature for efficient oxidation, a low concentration of the leuco-base in the anolyte, and sulphuric acid as solvent and electrolyte. The highest dye yield was obtained with uranyl sulphate as catalyst, platinum kathode, and nichrome gauze anode in dilute sulphuric acid solution at a temperature of 85° C. AUTHORS.

1494. *Factors Influencing the Electrolysis of Organic Compounds.* **R. Freas.** (Am. Electrochem. Soc., Trans. 40. pp. 109–120; Disc., 121, 1921.)—A contribution attempting to encourage further research and study of the electrolysis of organic compounds. The discussion, limiting itself to electro-reduction processes, states that the concentration of a "depolariser" relative to that of active hydrogen or H^-, as well as H^+, determines the nature of reduction possible. The factors influencing the relative velocities of reaction are enumerated, and in spite of their great number the author maintains it possible to secure selective reduction electrolytically. An experimental arrangement used, and adaptable to continued study, is presented. AUTHOR.

1495. *Anodic Behaviour of Manganese in Alkaline Solutions.* **G. Grube** and **H. Metzger.** (Zeits. Elektrochem. 29. pp. 17–30, Jan. 1, 1923.)—The anodic current density potential curves for manganese in 10*n* NaOH were determined over a range of current densities from A/dm^2 0·013 to 2·000, and at temperatures of 20°, 56° C., 80° C., 96° C. The results showed that pure manganese in hot concentrated sodium hydrate solutions passed into solution as divalent manganese at low-current densities, at medium current densities as trivalent, and at high-current densities as hexavalent manganese. In the hexavalent form manganate is produced, accompanied by an evolution of oxygen. The anodic oxygen evolution is accompanied by the formation of a layer of manganese dioxide, and forms permanganic acid

$$MnO_2 + 2H_2O + 3 + \oplus \longrightarrow MnO_4' + 4H.$$

This decomposes in *n* . NaOH with evolution of oxygen

$$2HMnO_4' \longrightarrow 2MnO_2 + H_2O + 3/2O_2.$$

At high-current densities this reaction only partially takes place, the alkaline solution diffusing and forming sodium permanganate. F. J. B.

1496. *Apparatus for the Electrolytic Preparation of Pure Hydrogen.* **G. Niese.** (Phys. Zeits. 24. pp. 12–14, Jan. 1, 1923.)—An apparatus is described for preparing pure hydrogen electrolytically from a 30 % solution of chemically pure sodium hydroxide. The electrodes are cylindrical and of pure nickel sheet, and a special arrangement is employed to prevent diffusion of oxygen from the anode to the kathode chamber. T. H. P.

1497. *Active Hydrogen by Electrolysis.* **A. C. Grubb.** (Nature, 111. p. 671, May 19, 1923.)—The author has obtained active hydrogen by electrolysing sulphuric acid. The hydrogen thus formed combines with nitrogen to form ammonia. W. R. C.

1498. *The Hydrogen Ion Concentration of Natural Waters and of some Etching Reagents in Relation to Action on Metals.* **W. R. G. Atkins.** (Faraday Soc., Trans. 18. pp. 310–315; Disc., 316–317, Feb., 1923.)—While engaged in work on soils and natural waters in their biological relationships, the author opined that his results from the study of their slight acidity, or alkalinity as the case may be, might be useful to workers on corrosion and in metallography. Natural waters are usually found to have acidities between *p*H6 and *p*H8·3, unless when rendered more acid by oxidation of sulphur from pyrites or by metallic salts. Bog pools may be as acid as *p*H5. Photosynthesis increases the *p*H value. The hydrogen ion concentrations produced by certain salts are recorded, and the limits for initial and complete precipitation of a few hydroxides are given with approximate accuracy. Ferrous salts in solution become more acid on standing, with precipitation of ferric hydroxide. The latter is completely precipitated before the ferrous hydroxide, as the solution is made progressively more alkaline. These facts are considered in relation to the rusting of iron, and it is shown that even at *p*H7·1 the precipitation of ferrous hydroxide is incomplete. Hence a trace of acid suffices to attack iron, and the hydroxide produced through hydrolysis is oxidised and precipitated. The hydrolysis equilibrium is thereby upset and acid is regenerated. Attention is drawn to the possible utility as etching agents of buffer mixtures and of acids of relatively low hydrogen ion concentration. An interesting discussion is given as an appendix.
H. H. Ho.